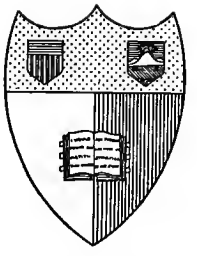
THE AMERICAN SUGAR INDUSTRY

TYPICAL SUGAR BEET

A PRACTICAL MANUAL FOR FARMER OR MANUFACTURER CAPITALIST OR LABORER STATESMAN OR STUDENT

HERBERT MYRICK



THE AMERICAN SUGAR INDUSTRY

A practical manual on the production of Sugar Beets and Sugar Cane, and on the manufacture of Sugar therefrom

PREFACED BY A TREATISE ON THE ECONOMIC ASPECTS OF THE WHOLE SUGAR QUESTION AND ITS BEARINGS UPON AMERICAN AGRICULTURE, MANUFACTURES, LABOR AND CAPITAL

Constituting a handbook for the Farmer or Manufacturer, Capitalist or Laborer, Statesman or Student

By HERBERT MYRICK

Author of "Sugar, a New and Profitable Industry," "Leaf Tobacco," "The Hop," "How to Co-operate," Editor American Agriculturist, Orange Judd Farmer, The New England Homestead, Farm and Home, Treasurer American Sugar Growers' Society, etc., etc.

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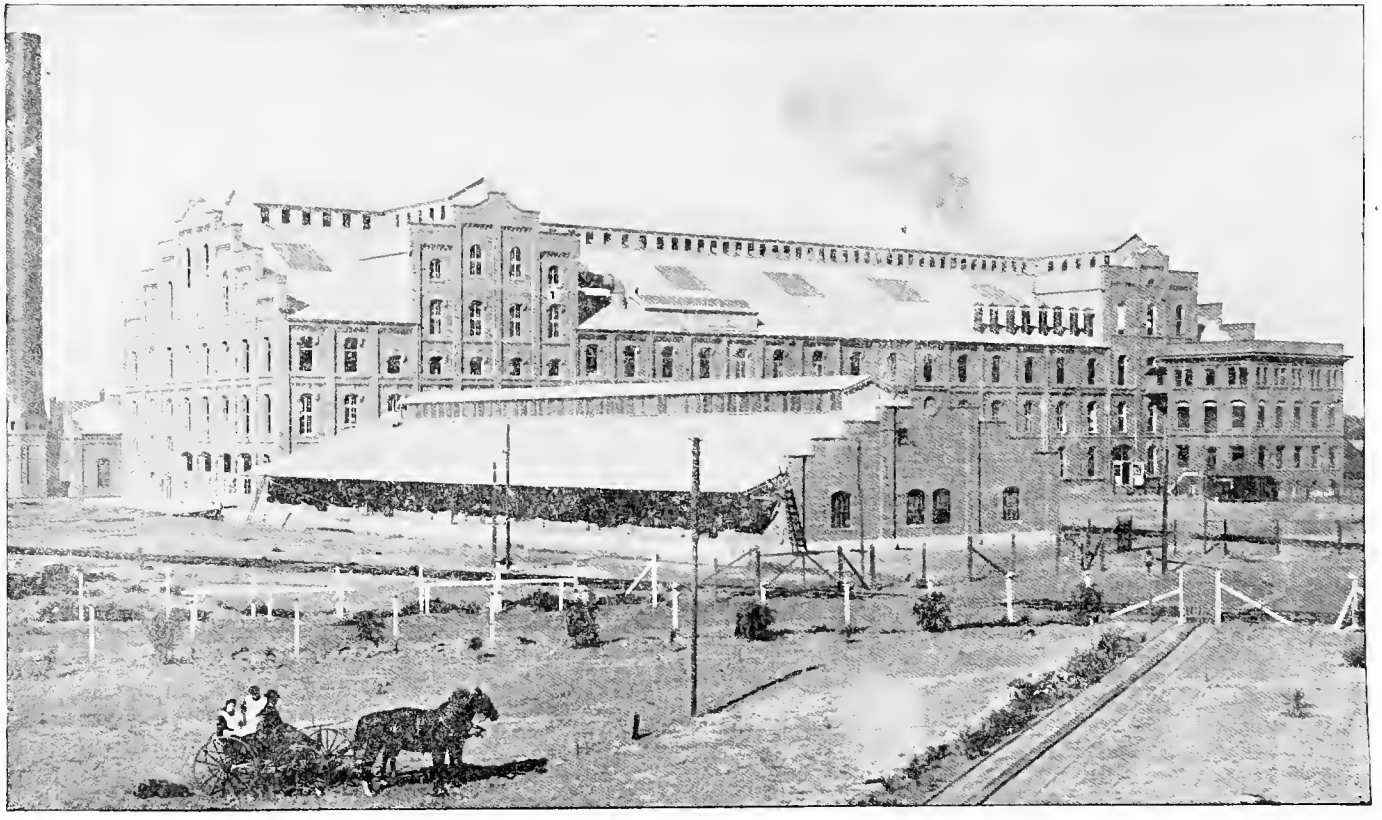

THE MODEL BEET SUGAR FACTORY OF AMERICA.

Property of the Pacific Sugar Co. Located at Oxnard, near Hueneme, Ventura county, California, about 75 miles from and nearly due west of Los Angeles. Viewed from the southeast. In foreground, warehouse for 10,000,000 pounds sugar, 222x85 feet, brick and iron, joins at right angles the main building in rear. The latter, or factory proper, is 401x121 feet, 100 feet to peak of roof, steel frame, iron roof, brick walls, concrete floors, with three main floors and nine partial floors. At left, steel stack of boiler house, 12 feet in diameter, 156 feet high. At right, four-story office building, 40x50 feet, connected with factory by bridge.

DISTANT VIEW OF PACIFIC SUGAR FACTORY

From southwest. At extreme right-hand corner of main building, rear, vertical lime kiln is shown. Other buildings as described in Part Four, Chapter III.

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Author's Preface.

In January, 1897, appeared the author's first book on this subject, entitled "Sugar, a New and Profitable Industry in the United States, for Agriculture, Capital and Labor, to Supply the Home Market with $100,000,000 of Its Product." That book was received with favor, not only among farmers and capitalists and by the press, but especially in the Congress of the United States and by American statesmen at home and abroad.

National legislation favorable to the development of our domestic sugar-producing industry was enacted by the Congress during the summer of 1897. This was followed by a phenomenal interest in America's domestic sugar industry, which, however, gave way to uncertainty with the advent of the Spanish war and the problems raised thereby. Provided those problems are now solved with due regard for American interests, it only needs proper direction and right management to secure for the United States large and permanent good from a vast development of its domestic sugar-producing industry.

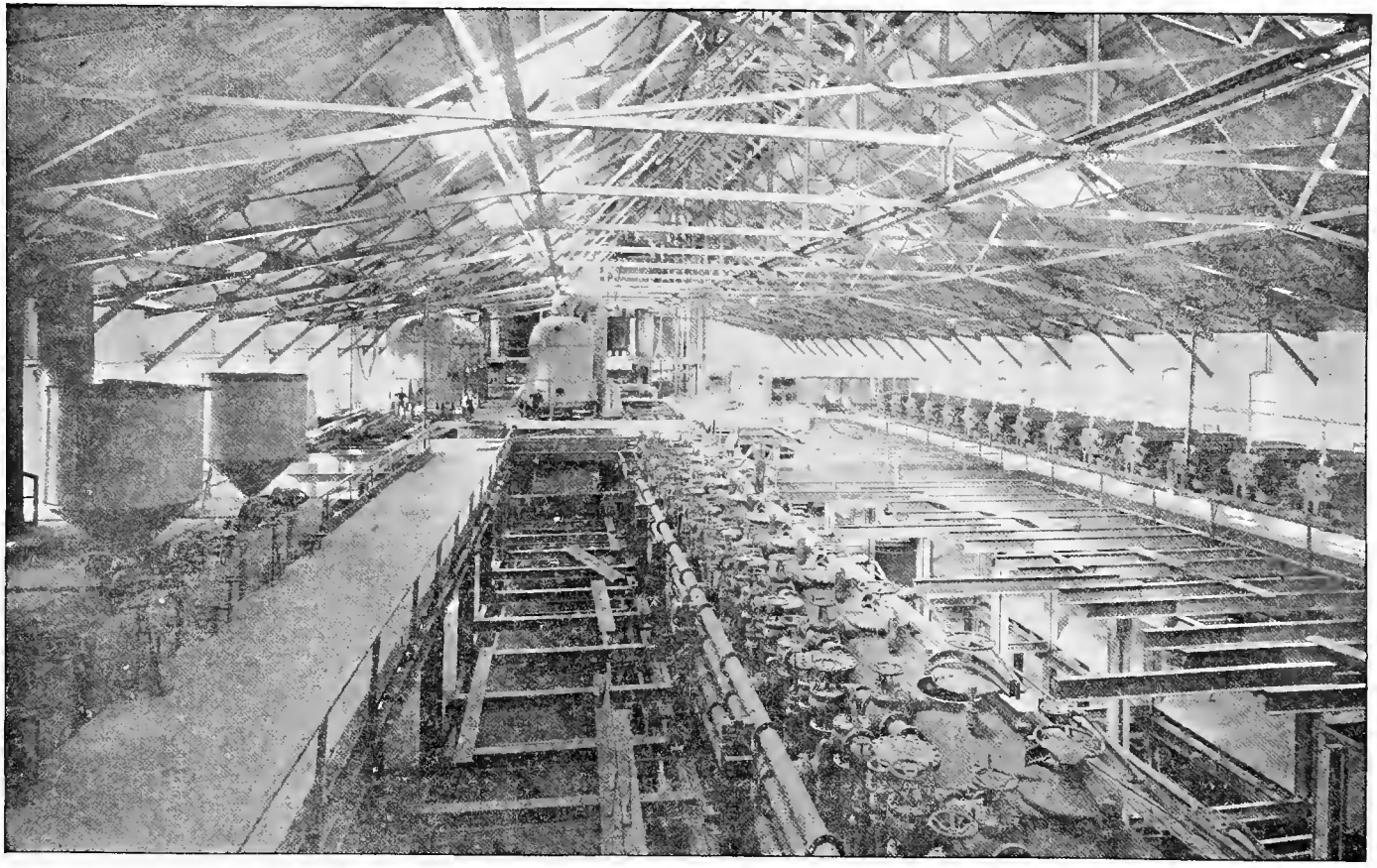
Many of those best capable of judging have been kind enough to partly attribute the promising outlook for this new industry, at the outbreak of the Spanish war, to the book referred to, to the American Sugar Growers' Society organized by the author, and to the agricultural journals under his editorial direction. This would seem to impose upon the author a moral obligation to do whatever lies in his power to help the industry through its new politico-economic crisis.

It also seems incumbent upon the author to present the important scientific, practical and financial results of the seasons of 1897 and 1898, in addition to the fruits of all prior experience. Thus unfortunate and costly mistakes in this new industry may be avoided, and uniform success attained by both farmer and capitalist.

In order that Congress and the general public, as well as farmers, may obtain a true idea of the magnitude and promise of this new industry in various directions, an appendix is added to accommodate the announcements of machinery builders, furnishers of seeds, supplies and implements, communities that want sugar mills, settlers, etc. No one can look through these announcements without being deeply impressed, while they also constitute a most useful directory of everything pertaining to the sugar industry.

Embodied in this new edition are Parts Two and Three from the author's first work, the better to reflect the evolution of the industry and to emphasize the teachings of experience. This is perhaps an unique plan in a book, but if so it is merely in keeping with the unique spectacle of a nation of 75,000,000 people attempting to speedily develop its domestic sugar industry.

THE AUTHOR.



INTERIOR OF THE MODEL BEET SUGAR FACTORY OF AMERICA.

Viewed from the middle, looking west. At extreme right, above, 25 filter presses. In middle, battery of 14 diffusion cells, iron hopper beneath to catch pulp when discharged from cells. At left, saturation tanks, eight in all, only two showing. In background, two batteries of quadruple-effect evaporators. Glimpse of two vacuum pans in extreme background. Open spaces for duplicate equipment, to double capacity of mill.

PART ONE.

Economics of Domestic Sugar Production.

CHAPTER I.

SITUATION AT THE OPENING OF 1899.

An entirely new danger now threatens the otherwise promising domestic industry of sugar production. It is the proposed free admission into the markets of the United States of sugar from Porto Rico, Cuba, the British West Indies and the Philippines and the continuance of the contract labor system in Hawaii. But for these dangers, there would now be under construction many new and large beet sugar factories in the eastern, central and western states, and extensive cane sugar houses in Louisiana, Florida and Texas. With four-cent cotton at the south and wheat down again to low prices, the importance of developing the domestic sugar industry may be emphasized by rehearsing a few comparisons.

The value of the sugar imported into the United States averages about $100,000,000 each year. The quantity doubles every fifteen years. Besides this, the imports of tobacco, wool, cotton, hides, vegetables, breadstuffs, fruits and nuts, dairy produce and eggs, hay and hops, rice and flaxseed, bristles and hair, bark and sumach, etc., represent in value another $100,000,000. This is somewhat less than formerly. But it is true that within the present limits of continental United States could be produced all these $200,000,000 worth of agricultural imports without materially affecting American agricultural exports.

Taking the fiscal year 1896 as a fairly average one for our foreign trade, and it appears that "every pound of the wheat and flour exported from the United States that year was barely enough to pay for the sugar imported. The total value of all live and dressed beef, beef products and lard exported that year barely equalled the amount paid for imported sugar. The immense export trade in cotton represented in value only twice as much as the import of sugar. The vast exports of tobacco must be magnified thrice to counterbalance sugar imports. The barley, oats and rye, fruits and nuts, hops, vegetable oils, oleomargarine, butter and cheese, pork and hams that were exported that year all put together represented in value only two-thirds of the sugar imported."

WHAT THE SUGAR INDUSTRY MEANS TO THE UNITED STATES.

Taking the imports for 1895-6 as representing the fair average importation of sugar, say 1,720,000 long tons annually, to produce this quantity would require 920 factories, each working up 350 tons of beets during a campaign of 100 days of 24 hours. Each factory would need 2,000 to 2,500 acres of beets, or about 2,000,000 acres in all. As the crop should be rotated and only grown on the same ground every third year, three times as large an area would be needed.

At an average of only ten tons of beets per acre, the total crop would approximate 20,000,000 tons. At only $4 per ton net for beets delivered to the factory, the farmers

would receive $80,000,000 for this new crop. That is to say, this money would go into our farmers' pockets each year instead of being sent out of the country to pay for imported sugars.

Each factory would cost about $350,000, or over $300,000,000 for the 920 factories needed to make our own sugar. The cost of labor and materials for running each factory, aside from beets, would be about $500 a day during the campaign, or $50,000 for the season. Thus the annual distribution for labor and materials would approximate $45,000,000!

Each of these 900 or more sugar mills means the distribution every year in the immediate community of the following amounts:

For beets, 30,000 to 50,000 tons	$150,000 to $200,000
Factory labor and supplies	50,000 to 75,000
Repairs, salaries, etc	10,000 to 25,000
Profits and reserves	25,000 to 75,000
Total	$235,000 to $375,000

It is safe to calculate on a yearly turn-over by each factory equal in amount to its capital, under average conditions. This is even more true of the larger sugar factories. It is proving true of the mammoth concerns that are growing up in California, each representing an investment of from $1,000,000 to nearly $3,000,000. Indeed farmers will be paid $2,500,000 or more each year for the beets needed to supply only the two mills at Watsonville and Salinas in that state.

CONGRESS RECOGNIZED THE GREAT POSSIBILITIES

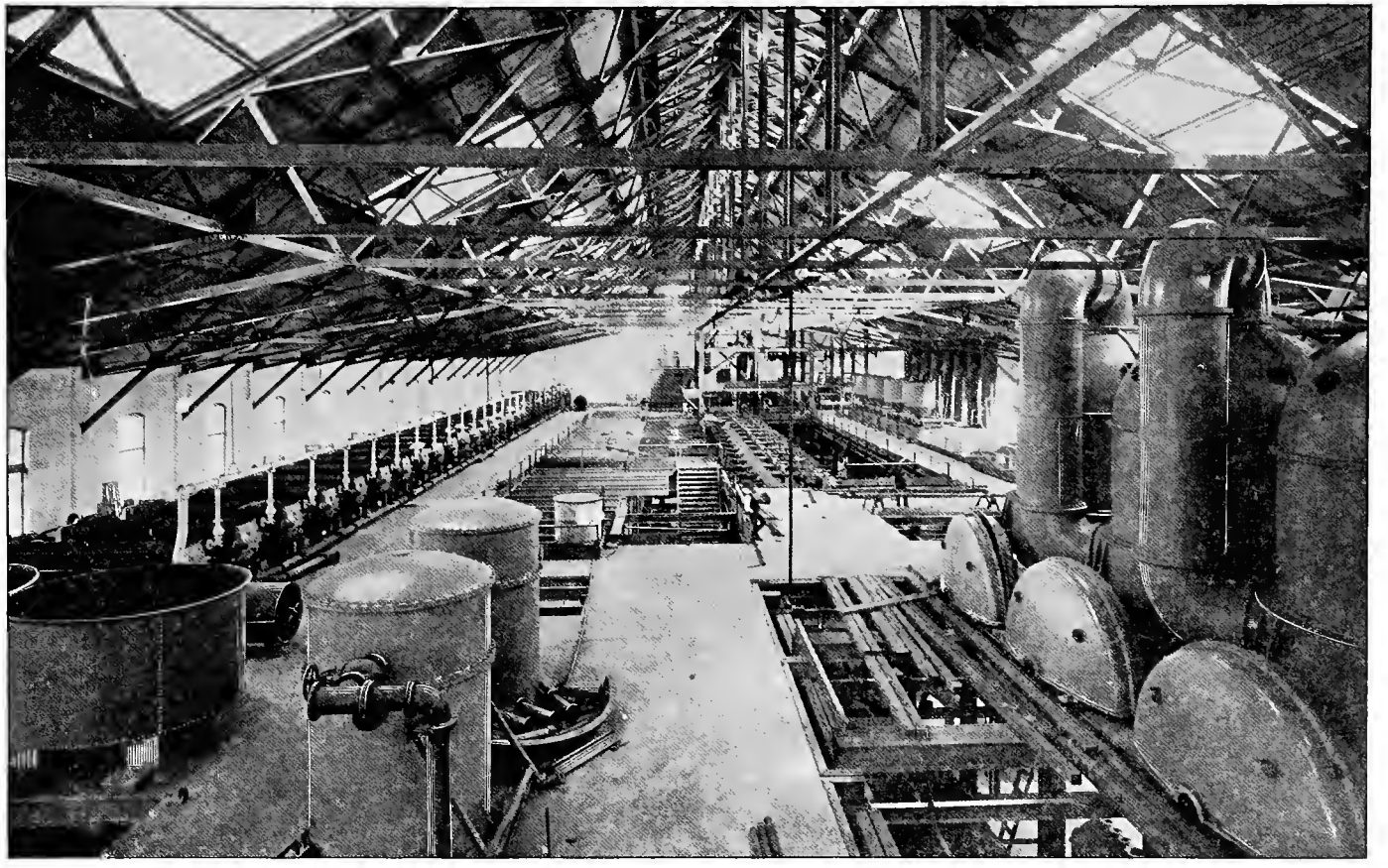
of the domestic sugar industry and in the Dingley tariff of July 24,1897, endeavored to provide suitable protection to both producers and refiners. That tariff was not secured until after a bitter fight, in which the American farmer for the first time came to the front and demanded that the sugar schedule should be framed in the interests of the domestic grower of sugar beets and sugar cane, instead of being framed to specially protect the refiner of imported raw sugars.

The Dingley tariff is serving its purpose well. Owing to large imports before it went into effect, its operation for the fiscal year 1898 is only indicative of what may be expected from the present sugar schedule if it continues to be fairly enforced against all sugars.

Certain friends of the American Sugar Refining Company, or sugar trust, claimed the new law was especially favorable to that concern even after the House had compelled the Senate to recede from the Senate schedule that did foster the refiners at the expense of domestic producers. On the strength of this claim, the shares of the trust were "boomed" from around par to nearly 150. But in spite of the profits on imports at lower duties prior to July, 1897, the new law did not specially benefit the trust and its shares collapsed again. Indeed the imports of refined sugar under the Dingley tariff have been unexpectedly large.

Imports of raw sugar from Europe have almost ceased, owing to the higher tariff and the countervailing duties equal to European export bounties. Indeed only 158 million pounds of raw sugar were imported from Europe in 1898, compared to 1,899 million pounds in '97. Contrast this *decrease* of twelve-fold in one year with the *increase* of five-fold in Europe's sugar exports to the United States in '96 over '95!

Imports from the countries to the south of us also show a decline, largely owing to the continued curtailment of production in Cuba caused by the war.



INTERIOR VIEW FROM WEST END, LOOKING EAST.

At the right foreground, battery of quadruple-effect evaporators; extreme background, eight saturation cells. At the left foreground, two juice heaters; at extreme left, two blow-ups; in background, filter presses; in center background, battery of diffusion cells.

THE LARGEST BEET SUGAR FACTORY IN THE WORLD.

View of the new mill of the Spreckels Sugar Co., Monterey Co., California, from the west bank of Salinas river; the new town of Spreckels at the right. The picture also gives an idea of the beautiful Salinas valley. The magnitude of the main building is hardly realized in this view. This mammoth enterprise involves $2,500,000 of capital, and will be ready to start up in August, 1899. It will consume 3000 tons of beets per day of twenty-four hours, producing about 450 tons of sugar daily. The early crop is planted in January and with later plantings up to April will afford a continuous supply of beets from August to January. It is hoped to contract for at least 30,000 acres of beets for this one mill, and to produce 60,000 tons of sugar. A straight price of $4.50 per ton delivered at factory is offered, and as 400,000 tons of beets are wanted, it means that $1,800,000 will be paid out yearly for beets alone.

Only the yellow races have held their own in our markets. In '97 the sugar imported into the United States from the East Indies, Hawaii and Africa (Egypt) was double the imports of '95. The full increase was maintained in 1898. The imports of coolie-grown sugar into the United States are now some 600,000 tons per year, compared to only 250,000 so recently as 1892.

In two years Hawaii practically doubled its shipments of sugar to the United States, which in 1898 were 500,000,000 pounds, compared to 274,000,000 pounds in '95. That region is enormously increasing its output.

A JUST MEASURE.—THE DINGLEY TARIFF,

aside from the mistake of free sugar from Hawaii (for which it is not responsible), may therefore be said to be quite satisfactory to domestic producers, and is fairly designed to develop a great American sugar industry. For details of its operation, see Table A, appendix.

The present duties levied upon sugar imported into the United States are much lower than the tariff of any other modern nation, England excepted. The United States tariff on sugar is now only from one-half to one-fourth as much as European tariffs, as shown by Table B, appendix. This country pays no export bounty on sugar. It now offers less encouragement to domestic sugar production than any other modern nation, England alone excepted, and she is naturally ill-adapted to beet culture. Certainly, it is only fair that this slight measure of protection to our domestic sugar producers be not jeopardized by favors of any kind to tropical sugars.

A few more years of this policy, and the home production of sugar in the United States will become so large as to result in still further lowering prices to consumers, although consumers in the United States now pay much less for this necessity than any European people. A continuance of the present tariff policy will in time probably enable our producers to compete in the export trade. This has been the outcome of a similar policy regarding steel rails and a variety of manufactures, of which the export is now constantly increasing. Indeed steel rails are now being exported to all parts of the world at $15 to $18 a ton, which cost nearly ten times as much to import some years since.

EFFECT OF THE DINGLEY TARIFF

on the development of domestic cane sugar and beet sugar production in the United States is shown in detail in Tables C and D, appendix. Observe that in spite of 1898 having been the worst season in Louisiana for twenty years, the cane sugar industry shows a gratifying increase.

A most astonishing exhibit is afforded by the increase of the beet sugar industry in this country. Prior to the Wilson tariff of 1894, *six factories* were operating, employing some $4,000,000 of capital, using about 400,000 tons of beets and paying farmers therefor upward of $2,000,000 a year.

In 1899 these six old mills and *fifteen new factories* are now (January, '99) about ready to run, employing $10,000,000 of capital, and have already contracted for some 1,250.000 tons of beets, for which farmers are to be paid nearly $6,000,000.

This statement does not include any of the great number of beet sugar enterprises that are now in the formative stage. Many of these would have been under construction ere this, but for the uncertainties caused by the Spanish war and its results. Some of these enterprises are being rapidly pushed in order to have factories ready to work up the 1899 crop of beets, and in the confidence that Congress will not lower the tariff on tropical sugars. It is probable, therefore, that numerous additional factories will be

operating this fall, representing additional millions of capital and of money paid to farmers. But for an unprecedented drouth in California, the product of beet sugar in 1898 would have been much larger.

For a complete insight into the progress of the industry prior to 1897, see Parts Two and Three, while the results and lessons of 1897 and 1898 are fully stated in Part Four.

ALL THAT IS NOW NEEDED

to insure a speedy, permanent and profitable development of this industry in the United States, is the declaration by Congress that sugar from the tropics shall continue to pay the same duties in the future as in the past. Also prohibit coolie-contract labor in the Sandwich Islands, and avoid unjust reciprocity.

Millions upon millions of capital, domestic and foreign, will at once flow into this industry. It is conservative to say that, if Congress thus acts promptly, upward of $50,000,000 will be invested in new factories in time to work up the 1900 crop of beets. This would make a home market for some $25,000,000 worth of beets in 1900, in addition to the crop required for existing factories. Several millions would also go into the cane sugar industry of Louisiana, Florida and Texas.

I also venture the prediction that, if such politico-economic policy is at once determined upon and is not changed for ten years, long before 1910 the United States will be producing practically all the sugar it now consumes. This is a consummation devoutly to be wished.

THE VITALITY OF THIS INDUSTRY,

especially beet sugar, is shown by its development in the face of the greatest economic and political changes and uncertainties that ever beset a new industry. Just as it began to attract attention, the free-sugar law of 1890 offered a mighty stimulus to Europe's established beet sugar factories at the expense of the struggling industry in the United States, which our domestic bounty of 2c per lb by no means equalized. "Free sugar and a bounty," at that time was one of the greatest economic errors ever committed.

This was overthrown by the Wilson revenue tariff of 1894, which introduced an entirely new set of conditions. Then came the Dingley tariff of 1897, which had not been in operation a year before the Spanish war brought in wholly unexpected complications and uncertainties.

Surely it is not unreasonable to demand that now the present law be steadily maintained in full effect for a series of years. This demand is all the more reasonable in view of the fact that existing duties are less than one-half the average tariff now enforced by eight European nations.

WHY DID NOT THE AMERICAN SUGAR INDUSTRY DEVELOP EARLIER?

Because when the sugar beet was first tried, 20 and 25 years ago, other crops paid so much better that farmers did not have the patience to learn how to grow beets. The first factories were not well located to secure an abundant supply of rich beets. The whole thing was comparatively new, and beets were of poorer quality than now. Then, 10 and 12 per cent. of sugar in the beets was considered fair; now anything below 12 per cent. is not accepted at the factory, averages of 14 to 15 per cent. over large areas are not uncommon, while tests of 18 to 24 per cent. sugar in American beets are on record. The beet is a thoroughbred that improves in richness as a result of proper inbreeding and care. Another powerful obstacle to the beet-sugar industry in America 10 and 20 years ago was, that with high-priced wheat and virgin land free of cost, other crops were more profitable in comparison with the labor involved.

MINNESOTA'S FIRST BEET SUGAR FACTORY.

Located at St. Louis Park, between Minneapolis and St. Paul. The first campaign at this mill closed in December, 1898, with such encouraging results (see Part Four of this book) that its capacity will be doubled in time for the campaign of 1899. It has been abundantly demonstrated that Minnesota can produce heavy yields per acre of remarkably rich beets under proper culture. Interest in the new crop is keen throughout the state, especially in central and southern Minnesota.

With sugar cane, the industry prior to the war was conducted by slave labor and without much enterprise, the increase in slaves being an element of the profits. The industry was destroyed during the war. It took 20 years thereafter and an expenditure of $21,000,000 to rebuild the levees and reclaim the plantations, and it was not until 1878 that Louisiana's product was restored to the figures of 1844—115,000 tons. From 1878 to 1886 there was much trouble with high water and crevasses, while as early as 1884 an era of low prices set in, which were helped by a reduced scale of duties. Almost any other industry would have succumbed to such adverse influences, but our sugar producers, though discouraged, would not admit defeat. They established an experiment station to learn more about fertilizing and chemical control of sugarhouse work, changed in a large measure to the central factory system—just as the dairy people have done—improved the sugarhouse equipment, and by 1890 had doubled the crop of 1878. Then came the "bounty" period, in which the growth of production in four years was from 165,000 tons to 324,000 tons. Then came reduced duties in 1894, following which sudden change many plantations were sold for a song. But the Dingley tariff of 1897 restored fair prospects for the cane sugar interests of the United States.

Another reason why the beet sugar industry did not develop much prior to 1890, was that the United States department of agriculture, discouraged by a few failures, or blind to the merits of the beet root, led a wild-goose chase after sorghum. The possibilities of sorghum are not denied, but the practical realities of cane and beets are such as to eclipse sorghum for commercial purposes. After it had been demonstrated that sorghum was not a reliable sugar plant, as compared with sugar cane or the beet root, government spent millions of money and years of time upon it. Sorghum could be cheaply raised like corn, was not a "back-bending crop" like the beet. The *American Agriculturist* did what it could to stem the sorghum craze by showing what the beet sugar industry was doing in practice compared to the meager results of the sorghum theory, but it took years of bitter and costly experience on the part of government and farmers to vindicate our position. So the sorghum craze, fed from national and state treasuries, swept over the country for a dozen years.

But as it exploded, more work was done with sugar beets, until, when the McKinley law of 1890 was enacted, experience had pointed out the way to the success that has since been achieved. But hardly had a few beet sugar factories been established under the McKinley act before its repeal was ordered by the people. In spite of the ensuing uncertainties, the development of this industry since 1894, and especially since 1897, is proof conclusive of its necessity and its advantage to the whole United States.

Beet culture, however, cannot be learned in a single season. It is high farming, intensive horticulture, like the market gardening near our great cities, which is the result of fifty years of experience. Under the best management it takes from two to four seasons for the farmers in any locality to learn how to grow beets to the best advantage. Until this is done, the sugar factory is not assured of an abundant supply of beets of proper quality. Meanwhile the immense investment is at a risk—from $350,000 upward in each factory, and at best the factories can run only 100 or 150 days during the year. Experience in this country has demonstrated that where the industry has survived this first stage, it has in every case become well established, to the satisfaction and profit of the farmers, laborers, railroads and capitalists interested in the business.

And since the world's production of beet root sugar has increased from about 2,500,000 long tons in 1884 to almost double that quantity as the average since 1892, the general success of this industry is no longer questioned by any well-informed person. Indeed, nearly two-thirds of the world's consumption of sugar in 1898 came from beets.

CHAPTER II.

DOMESTIC SUGAR VS. "EXPANSION.

Nothing less than immediate, unconditional annexation of Porto Rico, Cuba and the Philippines and their admission to the Union as territories, with all the privileges of interstate free trade, irrespective of their form of government! This demand comes from Spanish property holders on these islands, and from a small but powerful coterie in this country that seeks to monopolize the cheap labor and marvelous productiveness of the tropics. Whether or not this demand is generally joined in by the so-called "expansionists," or "imperialists," those elements of the body politic are being industriously but stealthily "worked" in the interest of this scheme.

WHAT IS THERE IN IT FOR THE ANNEXATIONISTS?

By remission of duties they would make an extra profit of $30 to nearly $40 on every ton of sugar, $5 to $8 on every pound of cigars, $1.50 on every pound of wrapper tobacco, 35 cents on every pound of filler tobacco, $25 to $40 on every ton of rice and proportional extra profits on all early or tropical fruits and vegetables.

Because of the cheapness of production with tropical climate and labor, the profits of the business under free admission to this market would be quite "beyond the dreams of avarice." These crops and industries here in the United States would of course be ruined by such competition.

The inability of the domestic grower of beets and cane and of the manufacturer of sugar therefrom to compete with the tropics (at least for many years) is shown by the following comparative exhibit, based on official data and gold values:

	United States	West Indies	East Indies	Hawaii
Yield of sugar per acre, tons.....	1¼	2½	2½	4
Cost of sugar per ton.....	$75	$40	$20	$35

This is a fair mean under average conditions, though the yield for the United States may be criticised as too high and the cost as too low. On the other hand, experts will claim that the tropics can produce more sugar per acre and at less cost.

Quite likely the latter is true, for only on this basis can an explanation be found for the momentous increase in imports into the United States of sugar produced by the yellow races—from 250,000 tons in '92 to 600,000 tons per year. And this while Cuba's industry was almost prostrated by war!

In Egypt alone, over $50,000,000 have been invested in cane sugar houses and plantations within the past few years, mostly English money, at vast profit, owing to cheap fellah labor and great productiveness of soil under irrigation. Vast projects for further extensions are under way in Egypt and other parts of Africa.

The enormous profits in the Sandwich Islands are due in part to the marvelous productivity of Hawaiian plantations. The Ewa boasts of having produced an average of 8½ tons of raw sugar per acre in 1896, or four times the largest yield ever reported from Louisiana cane or California beets. Reports of the Ewa, Hutchinson and other plantations give the cost of production at from 1½ to 2 cents per lb, compared with 3 and 4

cents as the cost of making raw sugar from cane in Louisiana or beets in California or New York after the industry is well established. The enormous increase in the Hawaiian sugar industry, the immense plantations that are being developed and the preparations now on to double and triple the sugar output of those islands, are now matters of common notoriety, that have already caused a saturnalia of speculation.

Cuba has practically unlimited possibilities for sugar production. Porto Rico, though comparatively small in area, can, on a conservative estimate, produce almost as much as the present total yearly production of sugar in the United States! The Philippines possess sugar potentialities of unknown extent.

Much the same may be said of the tropical production of tobacco, rice, fruits, vegetables

PROTECTION FOR THE AMERICAN FARMER AND LABORER,

for the grower of sugar beets and sugar cane, against such competition will be necessary for some years to come. Every legitimate argument for the protection idea applies to this demand. None will undertake to gainsay this statement.

The battle for protection has waged these many years, during which the farmer has been more or less skeptical of its benefits to him. But irrespective of politics, the farmer (led by the Patrons of Husbandry) has come to agree that so long as there is a tariff he wants as much as the other fellow. And since only duties that directly benefit the farmer are those on agricultural produce imported, because not yet grown here sufficiently to supply the market, on such produce the farmer wants such protection equally with the manufacturer.

Now, if Congress overthrows such protection by admitting free sugar, tobacco, fruits, vegetables, rice, etc., besides adding to direct taxes, while at the same time continuing the manufacturers' protection, let no one be surprised if the farmers and working people vote in 1900 or 1904 to pitch the custom houses into the sea!

If there is to be any protection, the farmer wants whatever will benefit him. If there is to be free trade, then the farmer wants "freedom" for all. Of course the loss of revenue that free trade would involve would have to be made good by a federal income tax.

THE ENGLISH TARIFF APPLIES TO COLONIAL EQUALLY WITH FOREIGN PRODUCE.

The American farmer is perfectly right in this position, whatever are the relations of the United States to the tropics. Even England imposes the same duties on imports from her colonies—tea, coffee, tobacco, liquors, etc.—as from other countries. She gets one-fifth to one-fourth of her revenue from this source.

Now the whole imperialistic idea in the United States to-day rests on the claim that the United States Congress has ample powers to apply different tariff rates, other taxes and other forms of government in its dependencies in the tropics than are made mandatory within this union of states by the federal constitution.

LOSS OF REVENUE.

To admit tropical produce duty free would speedily sacrifice upward of $100,000,000 of tariff duties yearly. The $50,000,000 annually paid in duties on imported sugar and $20,000,000 on imported cigar-leaf tobacco (Table E, appendix) would largely go into the pockets of plantation and manufacturing syndicates in Cuba and the Philippines.

Revenue lost by the free admission of other tropical produce would go far to make up a total yearly sacrifice of $100,000,000. For it must be borne in mind that, with such

an enormous indirect bounty, production in the tropics would be vastly stimulated, and those regions would supply this market with millions of dollars' worth of produce and materials now obtained from other countries.

INCREASED TAXATION AND NEW TAXES.

There would naturally be a constant ratio of increase in such loss of tariff revenue on tropical production. Of course this loss of $100,000,000 in the customs would have to be made good by increased direct taxation of our people here at home.

The government expenditures incident to the war of 1898 and a policy of "expansion" will extend the annual expenditure of 1890 to '96 by a sum variously estimated at from $100,000,000 to $300,000,000 yearly. It is easy to see how, with loss of revenue incident to tropical free trade, taxes are likely to be increased by fully $250,000,000 annually.

This statement is not at all extravagant, in view of the proposed larger army, which alone is estimated to cost $90,000,000 a year by its author (Mr. Hull), and $150,000,000 by the minority of the House committee on military affairs. If the army costs $120,000,000 a year, it will equal what France and Germany each pay for an army five times as large. Besides this, the United States is paying out $150,000,000 yearly for pensions.

With decreasing imports and increasing expenses, surely this is no time to sacrifice the customs revenue. Indeed, a revenue tariff on certain articles now admitted free of duty, may be necessary.

TO SACRIFICE THE AMERICAN FARMER

for the benefit of colonial syndicates and Spanish real estate owners in the tropics is too preposterous to be seriously entertained for a moment. Yet it is the price demanded by certain annexationists. They bitterly resent the idea that the United States can impose duties on produce from the Philippines or Porto Rico after those islands have been ceded to the United States, but boldly demand free trade.

This is not the place to consider the various suggestions that have been made concerning the relations of the United States to the East and West Indies. But true it is that in an economic sense the issue is mainly agricultural. The farmer is the man whose business will be hurt the worst by annexation. The farmer is the man who, already bearing an undue proportion of the taxes, will be loaded down still more by the proposed additional taxes of $250,000,000 yearly. To rob him of his best market, to destroy his most profitable crops, to annihilate the sugar industry that means millions for a new and money-making crop, and then to pile more taxes onto him—no! American farmers will not for a moment submit to any such proposition. No political party has yet indorsed such an outrageous plan. The president is firmly against it if his advice about Cuba is to be taken at what he says.

INDUSTRIES TO BE HURT BY ABSORPTION.

The best things in agriculture to-day in the United States are the specialties that free trade with the tropics would knock out. That policy would permanently blight Florida and almost annihilate her agricultural industries, making Florida only a way station to the tropics. It would seriously compete with the important industry of growing early fruits and vegetables, both in southern and northern states. It would probably obliterate cigar leaf tobacco culture in New England, New York, Pennsylvania, Ohio, Wisconsin, Florida and Texas. It would transfer to Ponce, Santiago, Havana and Manila the vast cigar-manufacturing industry of the United States, whose skilled labor and millions upon millions of capital could not compete with labor at one-fourth our wages

working on tropical leaf. The extent to which the vast semi-tropic fruit industry of the south, southwest and Pacific coast would be injured by free trade with the East and West Indies is self-evident. The fruits of the northern belt would also be affected.

The production of sugar in the United States, already given a hard blow by the annexation of Hawaii, would be most seriously interfered with. In fact, sugar raised by the yellow and black labor of the East and West Indies, if admitted duty free, would probably annihilate our domestic sugar-producing industry. Louisiana and Texas alone can produce cane sugar enough to supply the whole country. Beets for the manufacture of sugar are now being grown with wonderful success in every state and territory from New York and Virginia to the Pacific. Such factories as are already established for the manufacture of beet sugar are doing splendidly over the Spanish war. Millions of capital are now ready to embark in numerous beet sugar enterprises in twenty states the moment Congress declares against free sugar from the tropics.

Thousands upon thousands of farmers in the sugar-beet belt are eager to grow all the beets needed to supply this country with all the sugar it consumes. Farmers realize that at $4 to $6 per ton, sugar beets afford the new and profitable crop they so much need. From both the agricultural and manufacturing standpoints, the beet-sugar industry in the United States is way beyond the experimental stage, and with a continuance of the present federal policy beet sugar offers one of the safest and most profitable investments for capital, agriculture and labor. And this in face of the fact that the average annual wholesale price of granulated sugar fell from 7.6c per pound in 1889 to 4½c in 1897, while to-day sugar is cheaper than ever before.

SUGAR BEETS A PROFITABLE CROP.

An acre of corn at the west, yielding 40 bushels of grain worth 15c per bushel, will buy something more than 100 lbs of granulated sugar at the grocery store. That same acre of land devoted to sugar beets will produce 2,000 to 3,000 lbs of refined sugar, like the finest white sugar you can buy. The corn under such conditions returns about $6 per acre for all the labor and capital invested in that crop. Sugar beets yield $25 to $50 per acre, and while they require far more labor, they pay for it and leave a net profit of $10 to $25 per acre, which is handsome compared to the meager returns from corn, wheat, oats, etc.

SUGAR AND THE MONETARY PROBLEM.

The country has been convulsed over the proposition of free silver coinage at 16 to 1. The most ardent advocates of that policy have not proposed to coin more than 100,000,000 silver dollars per year. Now without discussing the pros and cons of the silver question, no one will deny the benefits that would accrue by keeping at home the 100,000,000 of (gold standard) dollars that are sent out of the country each year for sugar. If this sugar is all paid for in money (instead of partly in merchandise), keeping at home this vast sum would inflate our per capita circulation nearly $1.50 each year or $15 in ten years, and in fifteen years it would double our present per capita circulation. Certainly it would help to solve the currency problem to keep at home the money that now goes abroad for sugar.

THE CASE IN A NUTSHELL.

The fact is that, after having given freely of our blood and treasure to drive out their Castilian oppressors, Spanish proprietors in the East and West Indies now seek a yearly bonus of untold millions from their deliverers. And certain combinations in the domestic sugar, tobacco, trucking and fruit trades have entered into an unholy alli-

ance to this end. So long as their enormous profits are sure, they don't care if thereby vast and promising domestic industries are destroyed, and $250,000,000 a year new taxes are piled upon the American farmer and people. History fails to reveal so shameless a conspiracy of pelf at the national expense. Its success would cause a moral decline and undermining of the basic principles of government that bode far worse for the republic than the sacrifice of men and money in the tropics and of material prosperity at home that this nefarious plan would involve.

NO COMPENSATING ADVANTAGES OF IMPORTANCE

have yet been demonstrated for such a result. It is probable that exports of certain manufactures from the United States to the tropics would be somewhat increased. It is true also that such an impetus to tropical sugar would greatly enlarge the demand for sugar machinery, etc., in those regions, but the whole world would compete in furnishing this machinery. Even if the United States furnished it all, the business thus obtained would not equal the volume of trade that would be created by building and equipping the nearly 1,000 factories (at an expense of $300,000,000) needed to supply the domestic continental market with sugar from crops grown by American farmers.

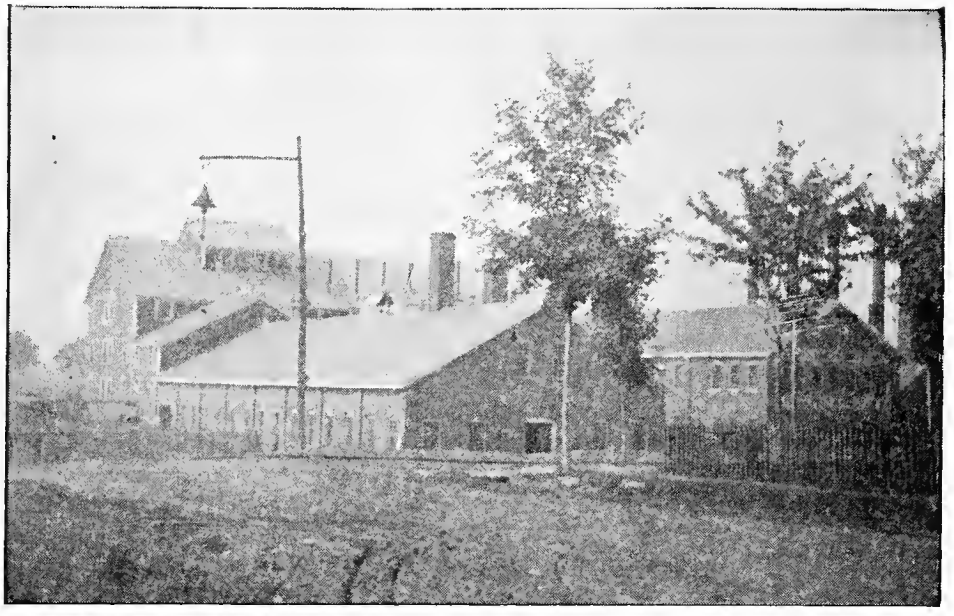
It is also claimed that such free trade with the tropics would vastly increase the export of cereals, meats and dairy products from the United States to those sections. Experience emphasizes the error of this hypothesis. The productiveness of the tropics is so liberal that the masses there do not require to import large quantities of food products, nor have they the ability to pay for such products. Experience under the reciprocity features of the McKinley tariff of 1890 showed how small was the increase in the market for American grains and meats in the West Indies, compared to Great Britain and Europe.

Nor is there much force to the argument that free tropical or colonial sugar would materially reduce prices to consumers in this country. It might for a short time, or just long enough to kill the domestic industry, but that accomplished it would be comparatively easy for the sugar trust (which is back of this annexation scheme) to control the supply and again force up prices. It must be remembered that the price of sugar at the present time is just about what it was under the free sugar McKinley tariff, with its bounty of 2c per lb to domestic producers. The present price of sugar is nearly 50 per cent. less than during the ninth decade. Sugar is as cheap here as in England, while it costs our consumers only about 5c per lb compared to 7 to 14c in Europe.

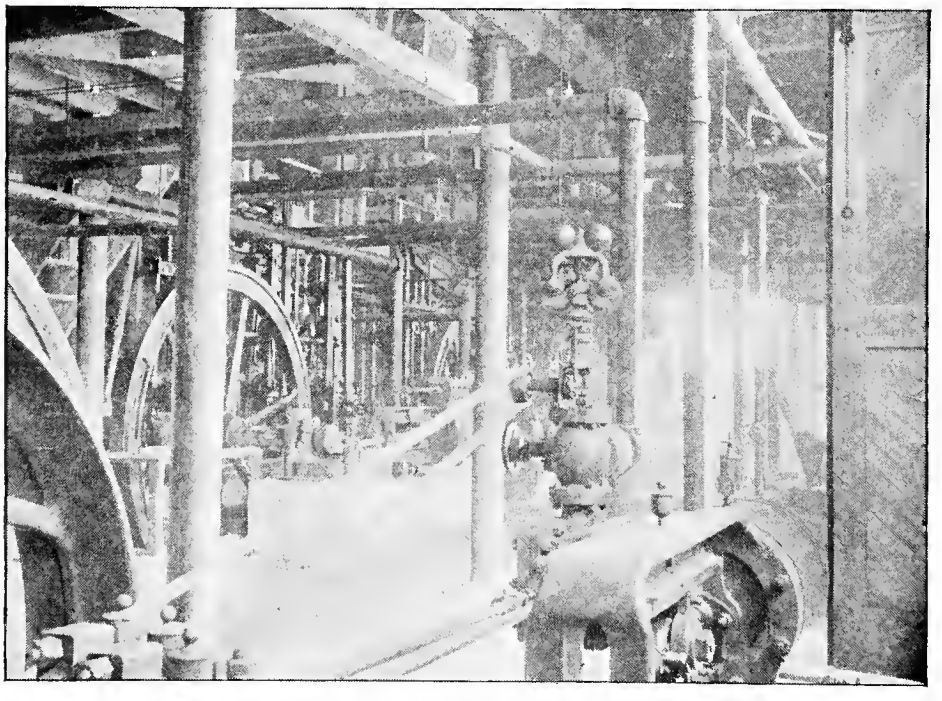
IN CONCLUSION.

There appear to be no valid reasons for sacrificing the interests of domestic sugar producers. There is every reason for maintaining the present tariff against all imported sugar from wherever it may come, for at least ten years.

American agriculture and labor believe the American Congress will do just this, the American people will back up such a policy, and the early future will vindicate its wisdom.



GENERAL VIEW OF THE BUILDINGS



A GLIMPSE INTO ONE OF THE INTERIORS.

The first New York Beet Sugar Company's establishment at Rome, N. Y. Main building 150x50 feet, three stories; another, one story, same size; a third is 140x120 feet, boiler-room 60x80. Equipment from abandoned factory at Farnham, Quebec.

CHAPTER III.

THE HAWAIIAN IMPOSITION.

Not content with securing the annexation of the Sandwich Islands under false pretenses, the coterie of cane sugar planters who control Hawaii now seek further special advantages at the expense of the American people and of the domestic taxpayer.

I use the term "false pretenses" advisedly. It was persistently represented by the Hawaiian sugar monopoly that no further increase in the production of sugar was possible in those islands. So adroitly was this point argued, that even the Honorable Secretary of Agriculture was led to indorse it, and it was then believed by every Senator and Representative who finally voted for annexation under the stress of war, which was also unduly magnified.

IT WAS ALSO FALSELY REPRESENTED

that, though sugar cane had of late years been grown only by coolie labor under contract, the planters would abolish the contract or slave system if the islands were annexed, and would hold themselves amenable to the labor laws of the United States.

To give color to this claim, a bill to prohibit importation of coolies was before the Hawaiian legislature in the spring of 1898. It was defeated, of course, as it was meant to be. The facts in the case were succinctly set forth in the San Francisco Chronicle for April 2, 1898, as follows:

CONTRACT LAW THEIR SALVATION—PLANTERS SAY ITS ABOLISHMENT WOULD MEAN THEIR RUIN.

HONOLULU, March 24.—The sugar planters are up in arms against a bill now pending in the Legislature providing for the abolishment of the labor contract system now in vogue, by which a laborer who deserts from a plantation can be arrested and thrown into jail until he is willing to return to his work and have all costs of his capture and detention assessed against him. The planters say that under the present condition the abolishment of the penal contract law would mean the utter ruin of every plantation on the islands. At a meeting of a committee representing the Planters' Association and the House Committee, to which the bill was referred, such men as John H. Hackfield, W. G. Irwin, F. M. Swansey, C. Bolte and H. Renjes were present, and all expressed the opinion that the passage of the bill would deal a death blow to the sugar industry.

The planters explained that the laborers brought to Hawaii are picked from the lowest classes in Japan. It is necessary to advance from $130 to $150 to each laborer to get him here. If, when he arrives he cannot be held to his contract, the plantation not only loses the man, but the money invested in him.

The new ruling of the Cabinet regarding the employment of European labor, the planters said, would secure immigration of white labor that, in a few years, would entirely replace the Asiatics on the plantations.

This proposition to abolish the coolie system was therefore a false representation for political effect upon Congress and the American people. At the very time it was being advanced at Washington, the Honolulu government was granting special licenses to the planters to import Japanese and Chinese coolies under contract. The new ruling, to encourage European labor, was another false representation, at least in effect, as

subsequent importations of labor have been 90 or 95 per cent. Japanese and Chinese coolies.

BUT THIS DELIBERATE BAD FAITH IS NOT ALL.

The government of the islands, which is admittedly merely holding over until Congress provides a permanent form of administration, has been diligently granting additional licenses to import coolies under contracts. These contracts run from three to five years. It is now brazenly asserted in official circles at Honolulu that, even if the United States government applies its alien-contract laws to Hawaii, the coolies who are now being rushed into the islands will be compelled to serve out their time. Honolulu advices dated October 11, 1898, and published in the American newspapers, reported the arrival of 2,000 coolies, and it is stated that the total importations during the calendar year 1898 will exceed 10,000 coolies.

The "hold-over" government at Honolulu has thus not only violated its moral obligations to Congress and the American people, but has done everything possible to gain added advantages for the island planters, in opposition to the laws of the United States.

Still more: The Hawaiian planters now insist upon the right to continue the importation of coolies. They have urged this point most emphatically upon the honorable commission appointed to investigate and report a plan for administrating the islands. The planters have further boldly declared their purpose to maintain a lobby at Washington until Congress grants them the right to contract labor in perpetuity.

History fails to record so colossal an exhibition of "gall." Granted free admission to the United States market for 20 years, this little body of Hawaiian planters drew $70,000,000 in bounties from the American people's remission of duties, until they became the wealthiest body of like numbers in the world. Annexation now perpetuates this remission of duties to an amount that will probably exceed $10,000,000 next year and is likely to largely increase in future. The planters are thus practically freed from taxation to support the United States government. In addition to all these priceless advantages, obtained largely as a result of bad faith, the Hawaiian syndicate now demands the right to employ slave labor!

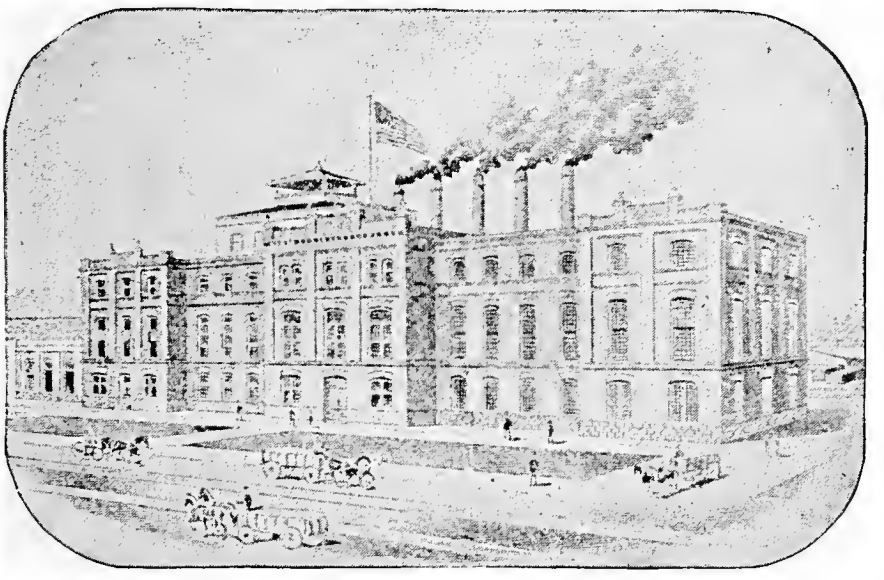
ABUSES AMONG THE COOLIE SLAVES.

The condition of these contract coolies is in many respects worse than that of slaves. They are paid $13 to $16 a month, less $3 to $5 per month deducted for food furnished, besides which they are given fuel, sheds to live in, and receive medical attention when sick. Their roofed sheds are filled with bunks. The immorality among them is most shocking. It cannot be even referred to in print. If the contract laborer refuses to work, the law allows his owner to fine him and he is also imprisoned until he does work. These coolies are procured by false promises of "an easy job." Japs resent the imposition and are cross and anxious to better their condition. They are kept at work only by severe overseers and fear of losing every cent they have earned, which can be taken away from them by the legal system of "fines." In a word, these coolies are owned bodily by their employers, and are so maltreated that they seldom renew their contracts and desert at any opportunity. Once a coolie gets free of his contract, he returns to his native land, or if he stays in Hawaii, it is as a "free" laborer. The very language of the plantation is that of slavery, with its "contract-men" for bondman or slave, and its "free labor."

SOME INTERESTING SIDELIGHTS.

on the contract-labor system are afforded by the following verbatim report, copied from the Hawaiian *Planters' Monthly* for December, 1897, Vol. XVI, Pages 595-6:

"To the President and members of the Hawaiian Sugar Planters' Association:—Some time ago your committee on labor mailed to the managers of all the plantations a circular letter asking for information in regard to the condition of labor on their estates.



MICHIGAN'S FIRST BEET SUGAR FACTORY.

Property of the Michigan Sugar Co., Bay City, Bay Co., Michigan. Capacity, 350 tons of beets per day, 3,500 acres contracted for the '98 crop, and some 7,500,000 lbs. of sugar were made during its first campaign ended in December, '98. The capacity is to be doubled for '99, and 7,500 to 10,000 acres of beets are wanted. The building is 264x108 feet, and four beet sheds 30x300 feet, with railroad and wagon tracks to each shed.

A series of 19 questions were put to each, with request that they answer them carefully and in full, they being assured that no one but one member of the committee would have access to their replies, and they would not be published except as a total. Replies have been received from all the managers but one, and the result of your committee's labor is embodied in the following:

"AVERAGE NUMBER OF LABORERS EMPLOYED DURING THE YEAR 1897.

	Contract Laborers	Free Laborers	Total av. no.
Japanese	6,379	5,371	11,750
Chinese	5,518	1,986	7,504
Portuguese	394	1,562	1,956
Hawaiian	430	988	1,418
Other nationalities			419
Total			23,047

"Supply of labor—45 well supplied, 6 were not; 25 reported many desertions, 21 none, 5 a few; nationality giving trouble—Japanese, a few reported Chinese; contracts expiring during year 2,235, as a rule contract men did not renew; 23 planters had difficulty in securing free labor, 28 had none. Rate of wages—7 paid $13 per month, 6 paid $14, 20 paid $15 to $15.50, 8 paid $16; Hawaiians were paid $17 and up, Portuguese $18 and upward."

From the foregoing, observe that Japanese furnished a little over one-half the sugar labor, Chinese about one-third, balance Portuguese one-sixth, with Hawaiians, South Sea Islanders and a few other nationalities.

AN UN-AMERICAN OLIGARCHY.

Even the San Francisco journal that ordinarily favored annexation, cannot stand this, but says:

"But the planters, having got used to coolies, want to keep them. That is natural enough, but it is not a consideration that appeals to people over here. Nor will Americans sympathize with their aspiration to maintain Hawaii as a rich man's paradise. The manner in which this is done is to use coolies, not merely in the cane fields, but in the trades and small retail enterprises to crowd out white men who might, if permitted to stay, outvote the sugar party in the affairs of the islands, secure the government, amend the labor laws, impose a fair rate of taxation upon the sugar estates and throw open the public domain.

"In their opposing attitude the Hawaiian planters resemble their prototypes, the slave-holding aristocracy of the south. They have no use for "poor white trash." Given their baronial acres, tilled by coolies and just enough white men to do their police work for them, and they are content. So long as the coolies are in hand they can keep the obstreperous and independent white at a distance. If he comes as a laborer he is confronted with a glutted muscle market; if he comes as an artisan, a skilled Japanese is set up in the same business to underbid him; if he wants to be a merchant, an Asiatic with planter backing drives him away. This is the Hawaiian fashion of managing things, but it is not American style, and we do not believe that Congress will engraft it upon the American system.

"The planters can till their fields with white labor under the profit-dividing system now being tried near Honolulu and still make fortunes. They can also do it by employing white farm hands directly, and for the general good of Hawaii they should be compelled to take some such course by the passage of laws discriminating against Asiatic labor in favor of the kind employed in this country. Otherwise Hawaii will be an anachronism in the American form of government."

Certainly, with all its advantages, natural and artificial, there is no special circumstance to justify Congress in perpetuating the contract-labor system on Hawaii.

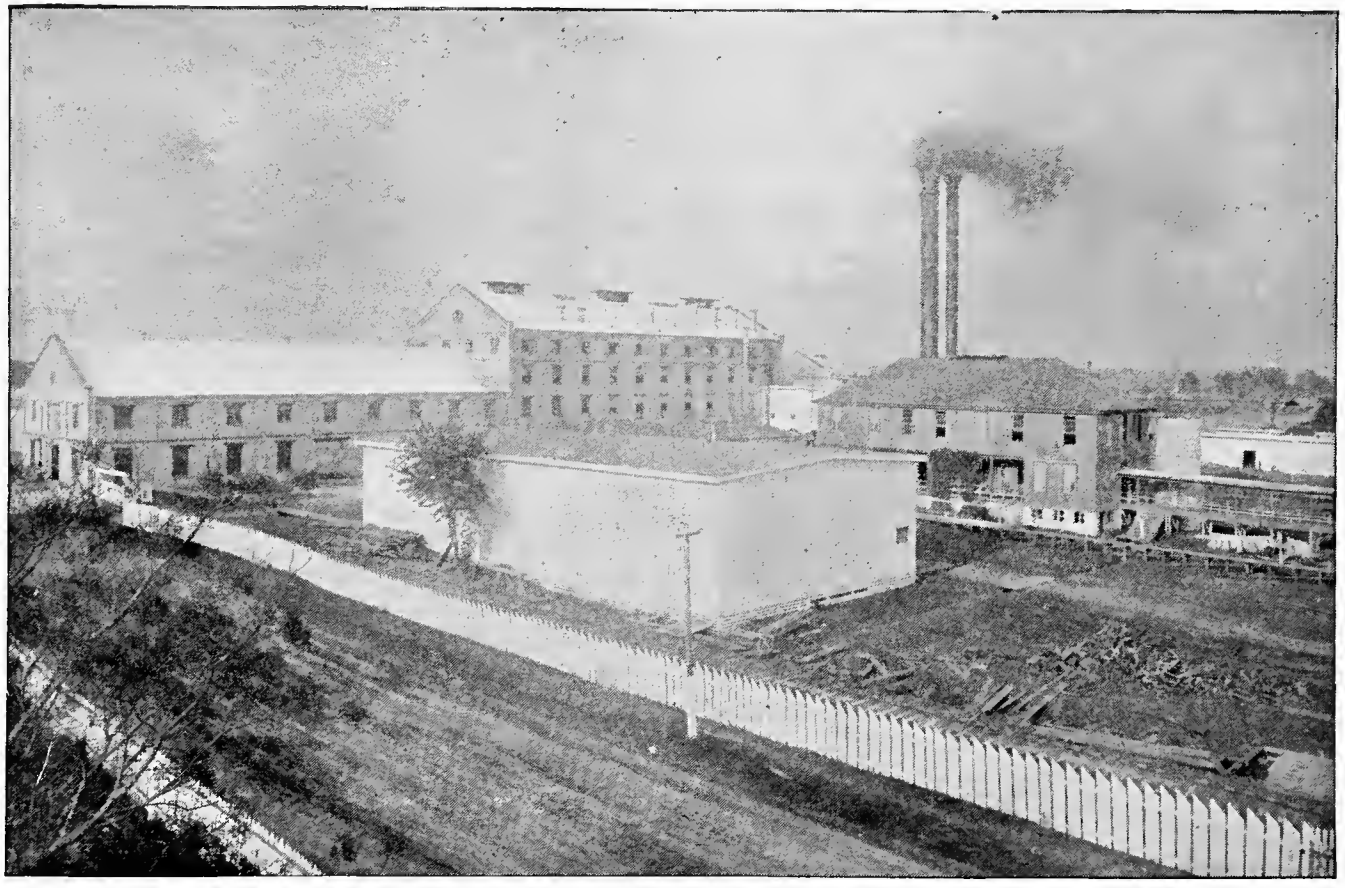
PART TWO.

THE CANE SUGAR INDUSTRY.

BY PROF. W. C. STUBBS,

Director Louisiana sugar experiment station at Audubon Park, New Orleans; director Louisiana state experiment station at Baton Rouge; director of the North Louisiana experiment station at Calhoun, etc., etc.

NOTE.—This chapter is designed to give a clear insight into this great industry at the South, but elaborate details of culture and management are omitted, because the industry is an old established one, and these matters are generally known to those now engaged in or likely to enter into the cane sugar industry. Reprinted from "Sugar, a New and Profitable Industry."

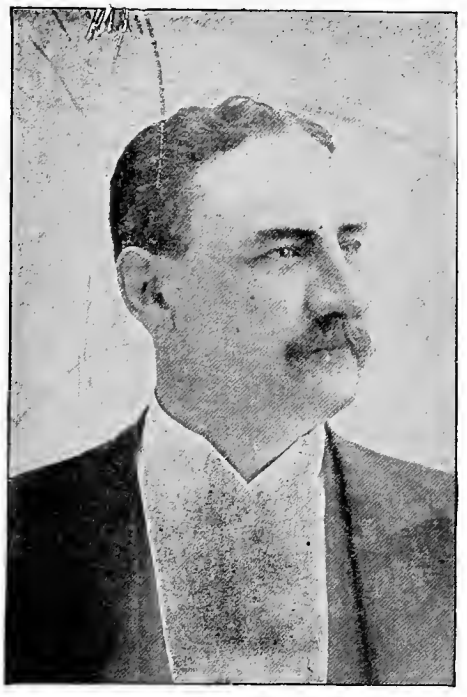


A MODERN SUGAR HOUSE ON A LOUISIANA PLANTATION.

This Caffery plant, near Franklin, has a capacity of 75,000 tons of cane per season.

PART TWO.

THE CANE SUGAR INDUSTRY.



CHARLES A. FARWELL,
First vice president American Sugar Growers' Society, President United States Cane Planters' Association, New Orleans, La. Having been in the sugar business all his life, and possessing the confidence of the whole sugar interests of the South, Mr. Farwell is a type of the men who are doing so much to develop this and other great industries in the South and throughout the country.

A BRIEF HISTORY of this industry is given on Page 12, from which it will be seen that it is a very old industry, although its principal development dates from about 1885. Cane was originally introduced into Louisiana by the Jesuits from San Domingo in 1757, but the ribbon cane now generally planted was introduced via Georgia from the island of St Eustatius. There are many varieties of cane and these are being daily increased by additions obtained from the planting of the true seed of the cane. The Louisiana sugar experiment station at Audubon park, New Orleans, is experimenting with over 100 varieties; of these, however, only two kinds are in general use in the state—the Purple or Black Java, and the Purple Striped Ribbon cane. A few planters grow a white variety known as the Light Java. These varieties were introduced about the year 1825 and have become so thoroughly acclimated to our soil and climate that they are now almost universally used.

THE AREA CAPABLE OF GROWING SUGAR CANE

is far larger than has been supposed. The sugar cane belt can be extended along the Gulf coast from a point near Savannah, Ga, running almost parallel to the coast line, to the northern extremity of Louisiana and on through Texas to the Rio Grande river. If irrigation could be secured, a portion of Arizona and New Mexico could also be utilized for this crop.

The area of cane in Louisiana for 1896-7 is about 300,000 acres. This amount can

be increased tenfold. In fact, I may almost say, without fear of contradiction, that there is hardly an acre in Louisiana that is not available for sugar cane under intelligent culture.

PECULIARITY OF THE CROP.

Cane culture has one peculiar feature, not possessed by hardly any other plant cultivated in the United States. The large amount of cane necessary to plant an acre (from four to six tons) makes it necessary to go slowly in the establishment of a large plantation. The usual method is to buy a carload or two of cane, plant a few acres and then use the entire crop of the next year in planting a larger acreage, and then the third year the entire crop in planting the plantation. In this way, it may be said to require three years to get into the cane culture upon a full scale. For this reason, the increasing and decreasing of a cane crop must be done gradually, and is unlike the beets, which can be increased or decreased annually at the will of the planter.

PRESENT OBSTACLES TO THE CANE INDUSTRY.

There is no doubt the area of cane will be greatly extended in the near future if we can receive substantial assurances of a permanent support against foreign competition. At present, capitalists hesitate to invest in an industry the prices of whose product are more or less influenced by a changeable congress at Washington. A permanent tariff is desired, in order that we may know and publish to the world what the profits will be under such a system. Having determined the profits, it will be easy (if the profits be remunerative), to secure capital to develop the large areas adaptable to the sugar cane.

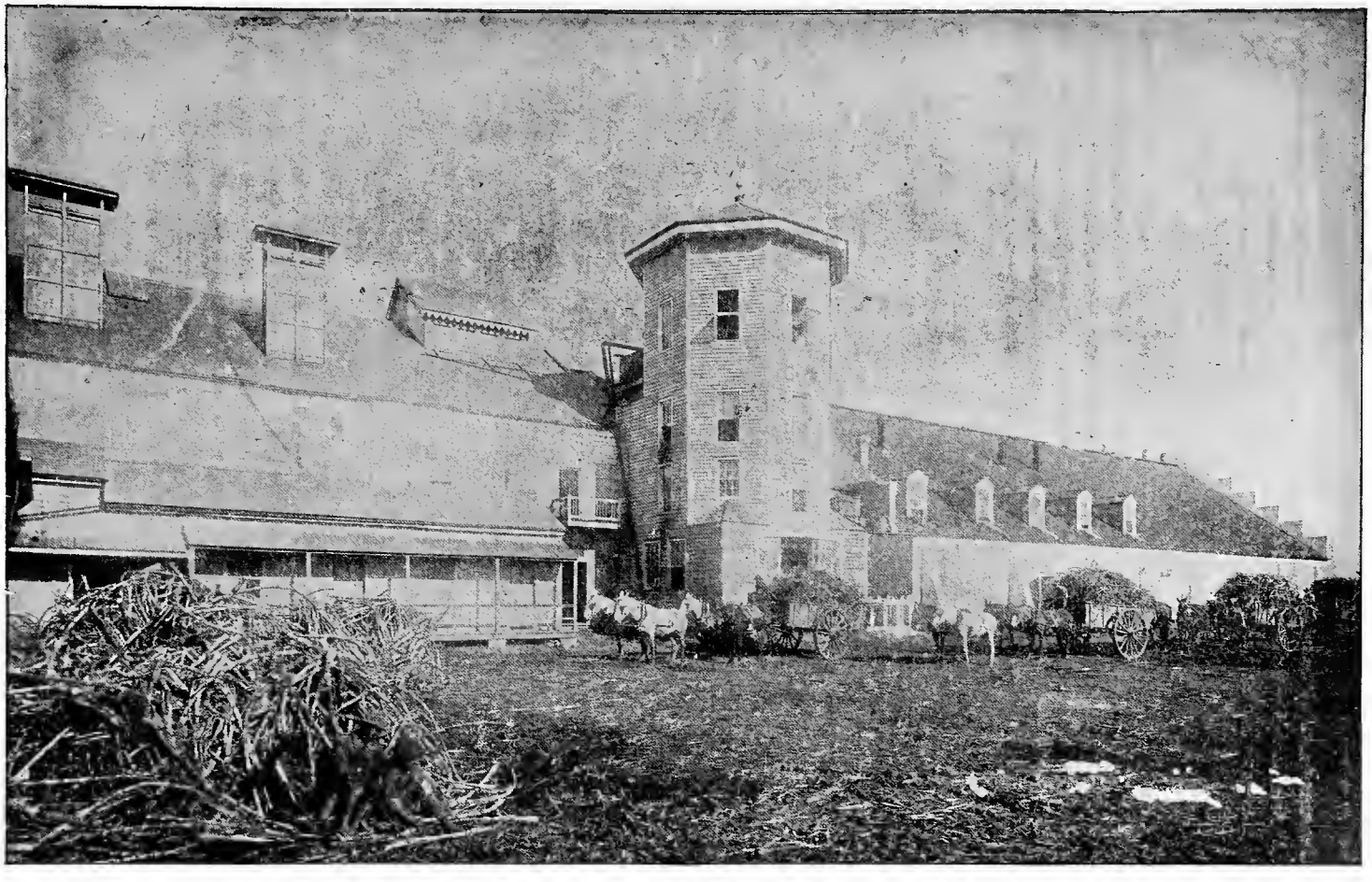
THE GREAT TROUBLE IN THE SUGAR CANE INDUSTRY

is the large cost of the machinery necessary to economically manufacture the cane. We have reached that point in the development of this industry, that the larger the factory the more economical the manufacture of cane into sugar. There seems to be no limit in the expansion of the sugarhouse. We have several in this state that are now working as high as from 1000 to 1500 tons of cane per day. This gives a factory the capacity of working 60,000 to 70,000 tons of cane in a season and some are able to work up even 100,000 tons.

The clientele attached to such a sugarhouse is but little larger or more expensive than one for a sugarhouse taking off 200 to 300 tons per day. In these days of close competition and small profit, the large sugarhouse will survive, while the small one must inevitably surrender. Hence, in establishing central factories, it is now the purpose to build as large as possible so as to make the manufacturing expense of cane as low as possible per ton.

To build and equip such a factory as this requires hundreds of thousands of dollars. These factories run only sixty to ninety days in a year, hence requiring the highest intelligence in every department to make the profit in these sixty or ninety days necessary to pay good interest upon the investment. The running of this sugarhouse machinery night and day, from start to finish, often hurried by the advent of a disastrous frost, causes a wear and tear which would not occur if it could be kept running regularly throughout the year, and at a regular rate of speed.

Moreover, while the sugarhouse is idle during nine or ten months of the year, the outfit depreciates in value, for idleness may be as injurious to machinery as wear



SUGAR HOUSE. EVAN HALL PLANTATION, LOUISIANA.

and tear. Hence the depreciation account of a sugarhouse is a very large item. It will be seen from this how different this industry is from running a refinery on raw sugar the year through, and how different it is from other kinds of manufacturing.

THE SOIL BEST ADAPTED TO SUGAR CANE

is a sandy loam, rich in vegetable matter. The cane does not seed, and since we grow it exclusively for sugar, the draft upon the soil is not heavy, provided the fodder and tops, the bagasse from the mill, and the ashes from the sugarhouse, are all carefully returned to the soil. But to make a crop profitable, a large amount of tonnage must be secured. It is nothing unusual to secure a crop of 40 to 45 tons of stripped cane per acre (though 20 tons is a fair average over a large area). Forty tons means fully 70 tons of green matter growing upon one acre of land; and while the per cent of nitrogen, phosphoric acid and potash is comparatively small, the aggregate of these three ingredients removed from the soil by such a crop is large.

The cane seems to be specially adapted to soils of an alluvial character on account of the tendency of these soils to make weed. The "raging fertility" of such soils has to be dampened by the growth of just such crops as sugar cane, which is a gigantic grass, before it can be adapted to the growth of cereals or other crops raised exclusively for the seed. Hence, the alluvial lands of Louisiana are peculiarly and singularly adapted to the cultivation of cane.

THE SOIL IS USUALLY PREPARED

in the following manner: Thoroughly broken with two to four horse plows, thrown up in beds six to seven feet in width, the middles deeply plowed and opened, and at intervals of short distances, what are termed quarter drains, running at right angles to the rows, are cut, leading into the ditches so that excessive rainfalls may be carried off without injury to the soil. This plowing is usually done in the fall;—though sometimes, from necessity, it is forced into the spring.

PLANTING.

After the soil is well prepared, the rows are opened with a double mold board plow, and the canes are deposited in this furrow—two to three continuous canes along the whole length of the row. These canes are then cut with a cane knife to adjust them to the ow, and covered either with a plow, a cultivator, or with a hoe. The planting is done any time between September and April. It is usually done by hand, though we have one or two cane-planting machines that have been experimenting in this line. After the cane has been planted, from each joint where is an "eye," springs a sprout. To assist this sprout in reaching the surface early in the spring, it is customary to scrape off the excess of dirt which was placed on the cane in the fall or early spring in order to protect it against the cold.

CULTURE.

After the cane has obtained a "stand," it is then cultivated, largely after the order of corn, care being taken to preserve always the cane upon a ridge so that the excessive rainfalls of summer may be easily disposed of. It is usually laid by in June

A CANE SUGAR PLANTATION IN SOUTHERN FLORIDA.

or early in July. After "lay by," the cane grows very rapidly, particularly if frequent showers at short intervals conspire with warm weather.

After the cane is planted we usually get two crops, sometimes three, from the same planting. The first crop is usually termed the "plant cane," and the second and third "first stubble" or rattoons. Cane is planted in this state so as to secure a continuous stand at maturity of from three to five stalks to the running foot. The stalks usually weigh from 2 to 4 lbs apiece. Like all grasses, cane tillers or suckers very greatly, and during the summer months many of these suckers or tillers perish. Hence the necessity of not planting cane too thick or too thin. If planted thickly, it will exhaust its energies in trying to sucker—a natural quality which seems to be exercised. If planted too thinly, the field will be filled at harvest with a large proportion of immature suckers, low in sugar.

HARVESTING.

In Louisiana the general harvest begins in October and lasts till January. In tropical countries grinding does not begin before January and usually lasts till June or July. In Louisiana, on account of the severity of our winter, cane must be harvested in the fall and winter or be killed. It is therefore only about eight or nine months old when worked in the sugarhouse. In tropical countries it is frequently fifteen and sometimes eighteen months old when harvested. Hence the superiority of tropical canes in sucrose over those grown in the southern part of this country.

In the latitude of southern Louisiana, we make a crop every year, while in the tropics only two crops are made in three years. Our less yield per acre than in the tropics is therefore somewhat made up. But, per contra, in the tropics, they only plant cane once in four to six years, while we must plant every other year.

ROTATION OF CROPS.

In Louisiana the regular rotation of cane is as follows: Cane, two or three years, and then followed with corn, sown broadcast at lay by with cowpeas (usually the clay variety), and the entire mass of vines and stalks turned under in August or September, and replanted in cane.

HOW TO START THE CANE SUGAR INDUSTRY.

A community can experiment to demonstrate what it can do with sugar cane in this way:

Let each individual plant sugar cane on a small area and manufacture it on a small scale, with horse mills and open evaporators, according to the old-fashioned system. In this way, the saccharine content of their cane and the average available tonnage per acre can be established. Then, they can present to the commercial world a valid argument to enlist capital in a factory. The average yield being say 20 tons per acre, 5000 acres would be required to furnish the maximum crop of 100,000 tons that can be worked up in a single season by a modern factory of large size. Certainly nothing less than 2500 acres under cane each year would answer for a modern factory.

The Louisiana experiment station at Baton Rouge has published a bulletin (No. 5) giving full directions about sugar making on a small scale, which also gives direc-

CUTTING SUGAR CANE, LOUISIANA.

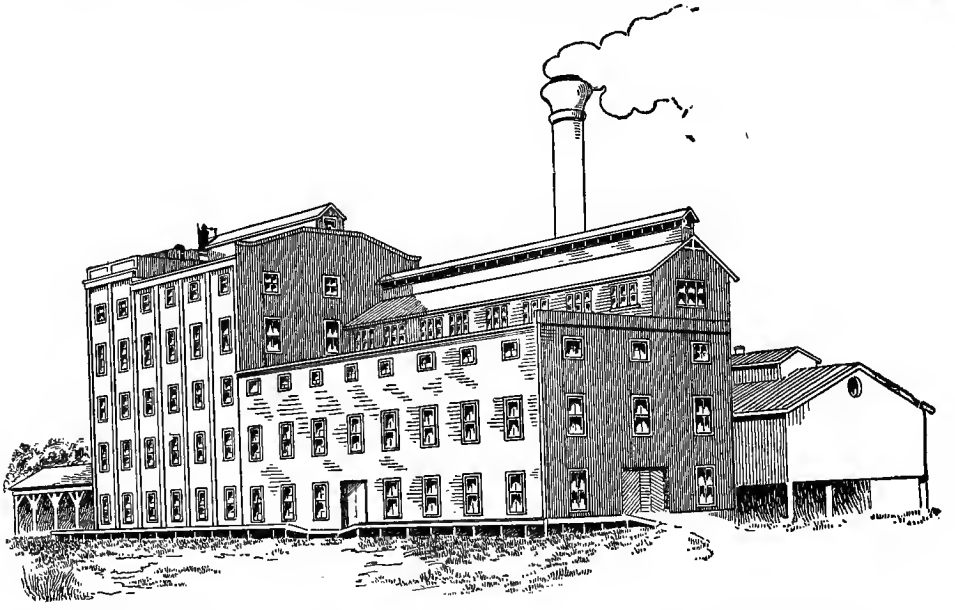
PHOTO BY MUGNIER, NEW ORLEANS.

tions for culture of the cane in a small way. A copy of it will be sent free to any one who applies to Baton Rouge for it in person or by mail.

The difficulties in securing a central factory for working up sugar cane are dependent entirely upon the slowness with which sugar cane plantations can be established. Cane plantations must be established before the factory will be secured, and farmers are slow to establish a crop which requires three years of work and patience, unless they have "an assurance doubly assured" of a factory.

DESCRIPTION OF MANUFACTURE.

Cane is hauled from the field and dumped alongside a moving platform, which



SUGARHOUSE ON ADELINE PLANTATION, FRANKLIN, LA.

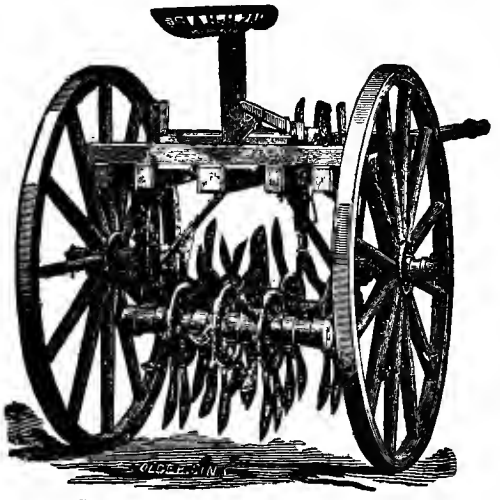
This plant is owned and operated by the Oxnard family, who are also interested in the beet sugar factories at Norfolk and Grand Island, Nebraska, and Chino, California. Like the latter plant, the Adeline sugarhouse has all modern improvements. This is the only instance we know of in the United States in which the comparative merits of the cane and beet have been closely compared for a series of years.

conveys it to the mill, and drops it, end on, into a chute which abuts upon the first mill—generally a three-roller mill, giving two pressures. Thence a conveyor takes the crushed cane to a second mill, where it gets a final squeezing and is ejected in a pretty dry state (called "bagasse"). This is conveyed by a third carrier to the bagasse furnace, wherein it is consumed as fuel and supplies steam power and steam heat to the sugar house.

Or, the cane may be cut up into small pieces by specially designed knives and carried into large cast-iron cells known as diffusers. Here they are treated by the diffusion process, as described later on in the chapter on manufacture of sugar from beets.

The juice, as it runs from the mill, is strained and limed and passes into the clarifiers, where the temperature is raised and the lighter impurities come to the surface

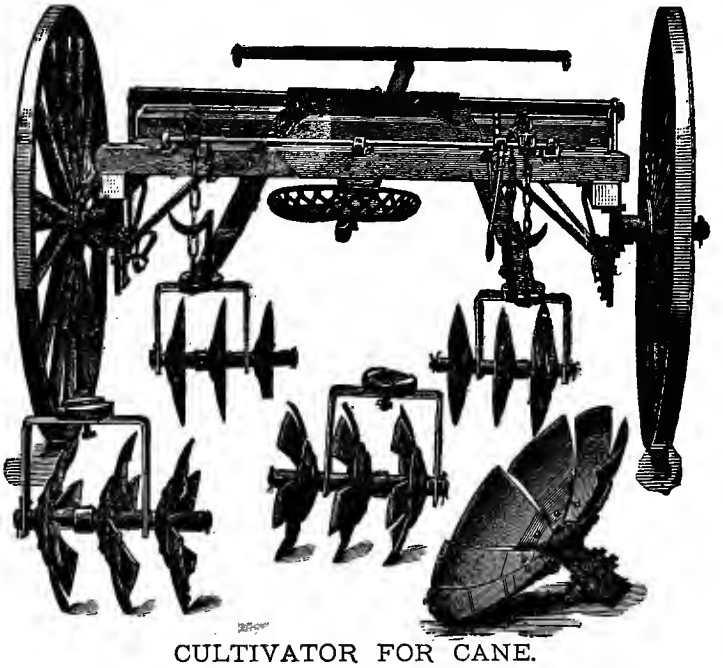
and are skimmed off, while the heavier go to the bottom, and the clear juice is drawn off and sent to the boiling-down apparatus, double or triple effect. Here it is concentrated into a syrup, again treated to remove impurities, and then goes to the vacuum pan, where it is boiled to grain. The contents of the pan are then sent to the centrifugal machines, which separate the sugar from the molasses, and the barreling of the sugar completes the cycle of operations.



CANE STUBBLE DIGGER.

A second crop of crystals, of lower grade, is made from this molasses, and its molasses is the final by-product. The scums and settlings are passed through filter presses and quite a quantity of sugar recovered from them.

A sugarhouse turning out one ton of sugar per hour will require about 90 men, skilled and unskilled, from the chemist to the trash boy.



CULTIVATOR FOR CANE.

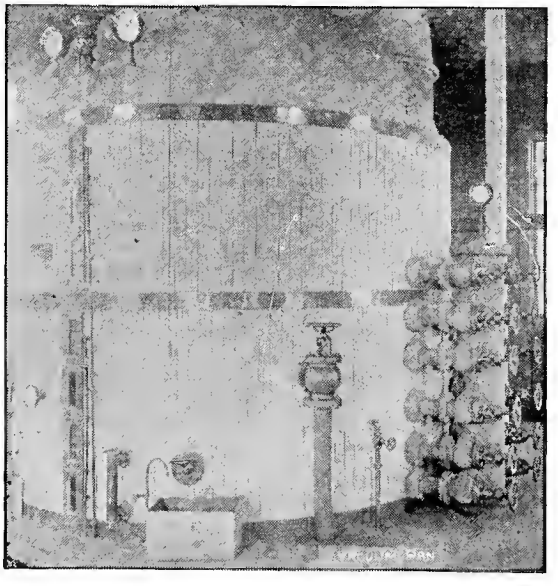
QUALITY AND GRADE OF PRODUCT.

The product from such a modern sugarhouse is called "centrifugal" sugar, as contrasted with sugar made by the old-fashioned, open-kettle process, which is known as

"open-kettle" sugar. By the latter system, the juice of the cane is evaporated in four large iron kettles arranged in a line. The juice, after being sulphurized, is drawn into the first or Grand kettle, where it is limed, heated and the scums removed. It is then drawn into the second or Flambeau kettle, where it is brushed and cleaned, then passed to the third or Syrup kettle, where it is further brushed, thence passed into the Batterie, where it is reduced to the granulating point. It is then dipped out into coolers and run into large strainers, which allow the molasses to drain off. The resulting "open-kettle" sugar is then ready for the refinery, and constitutes what was formerly known as brown sugar, but very little of it now reaches the market until after it is refined.

The commercial grades of these two kinds of sugar: Open-kettle sugars are raw and unrefined, the name of each grade, beginning with the lightest color, is as follows: —Choice, Strict Prime, Prime, Fully Fair, Good Fair, Fair, Good Common, Common, and Inferior.

The best grades of centrifugal sugars are almost as good in quality, appearance and saccharine strength as the best grades of refined sugar resulting from the refining processes employed in the very extensive refineries, most of which are operated by the "sugar trust." The best grade of centrifugal sugar is known as Plantation Granulated, and the other commercial grades are graded according to appearance, color, etc, as follows: Plantation Granulated, Off Granulated, Choice White, Off White, Gray White, Confectioners' Yellow, Choice Yellow, Prime Yellow, Off Yellow, Seconds.



VACUUM PAN,
At the Lehi, Utah, beet sugar factory.

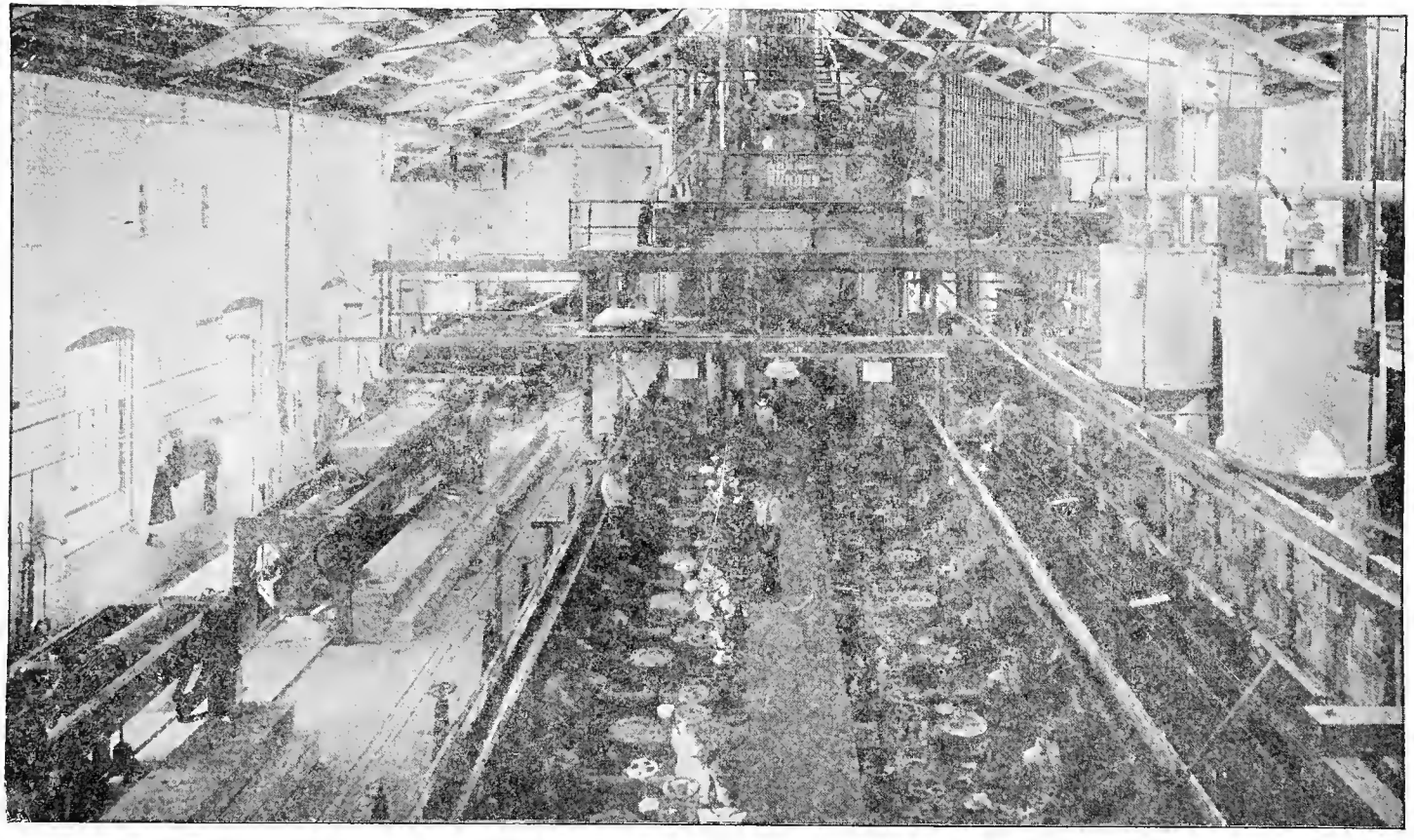
PART THREE.

THE BEET SUGAR INDUSTRY.

Prior to the close of 1896.

Embodying the actual results of all American beet sugar factories, the methods of the most successful practical beet growers in all parts of America, and the lessons acquired by the scientific work of the United States Department of Agriculture (Dr. Harvey W. Wiley, Chief of Division of Chemistry), and of the various State agricultural experiment stations.

BY HERBERT MYRICK.



Filter presses. In foreground, diffusion battery for extracting juice from sliced beets; at rear, scales for weighing beets, one ton at a time. Carbonation tanks for treating beet juic with lime and carbonic acid gas.

HOW BEET SUGAR IS MADE IN MODERN FACTORIES.—AT CHINO, CALIFORNIA.

PART THREE.

THE BEET SUGAR INDUSTRY.

CHAPTER I.

WHAT HAS BEEN ACCOMPLISHED IN AMERICA.

The first efforts toward producing sugar from the beet in this country were made near Philadelphia in 1830, without success. Eight years afterward, David L. Child made a crude attempt at Northampton, Mass, the beets averaging 6 per cent. of sugar. In 1863 the Gennert Brothers, from Germany, established a factory at Chatsworth, Illinois, a location illy chosen, it is said, in soil and climate. After struggling for several years, the factory was removed to Freeport, Ill, and later to Black Hawk, Sauk county, Wis, where it was started as a co-operative enterprise. From Black Hawk a portion of the machinery, at least, was removed to California. In all of the latter instances, there was more or less inefficiency in factory management, but the chief difficulty was the lack of interest on the part of farmers, and their failure to furnish sufficient beets. The quality of the beets was also very inferior. Even in California's early days, it was several years before they learned the proper stage of maturity at which to harvest the crop. Only an elaborate account of all these early efforts could give an insight into the trials and disappointments they involved, but the lessons of this bitter and costly experience have been made the most of, and paved the way for the successes of the past half-dozen years. We should not forget to honor the pioneers in this industry. About 1871 Messrs Bonesteel & Otto erected a small factory at Fond du Lac, which, after making some sugar, was dismantled and

FOUNDER OF AMERICA'S BEET-SUGAR INDUSTRY.

This is not too much to say of Mr Henry T. Oxnard, president of the beet-sugar companies operating factories at Norfolk, Grand Island and Chino. He organized the American Beet Sugar Manufacturers' Association, and has been the head and front of the development of the beet-sugar industry in the United States as a commercial enterprise. See pages 34-35.

the machinery removed to California. Late in the '70's, beet-sugar factories were established at Portland, Me, Franklin, Mass, one in New Jersey, and another in Delaware. In California, the Alvarado plant was established in 1870, and one at Sacramento in 1873, and one a distance below that city at Istleton in 1874 or '75. The two latter soon failed, and an attempt at Los Angeles, along in 1878-9, never amounted to anything.

A TYPICAL SUGAR BEET.

This beet was selected for illustration herein from a lot of 57 tons of "mother beets" chosen for seed-growing purposes by the Utah Sugar Co. The above engraving is just half size. The original beet was 13 inches long, exclusive of an inch or two broken off the tip. It weighed 28 ounces and contained 17 % sugar, of 84 purity. For seed growing, the top is left as shown, but for the factory, the butts of stems and woody matter forming the oval top are cut off square and clean.

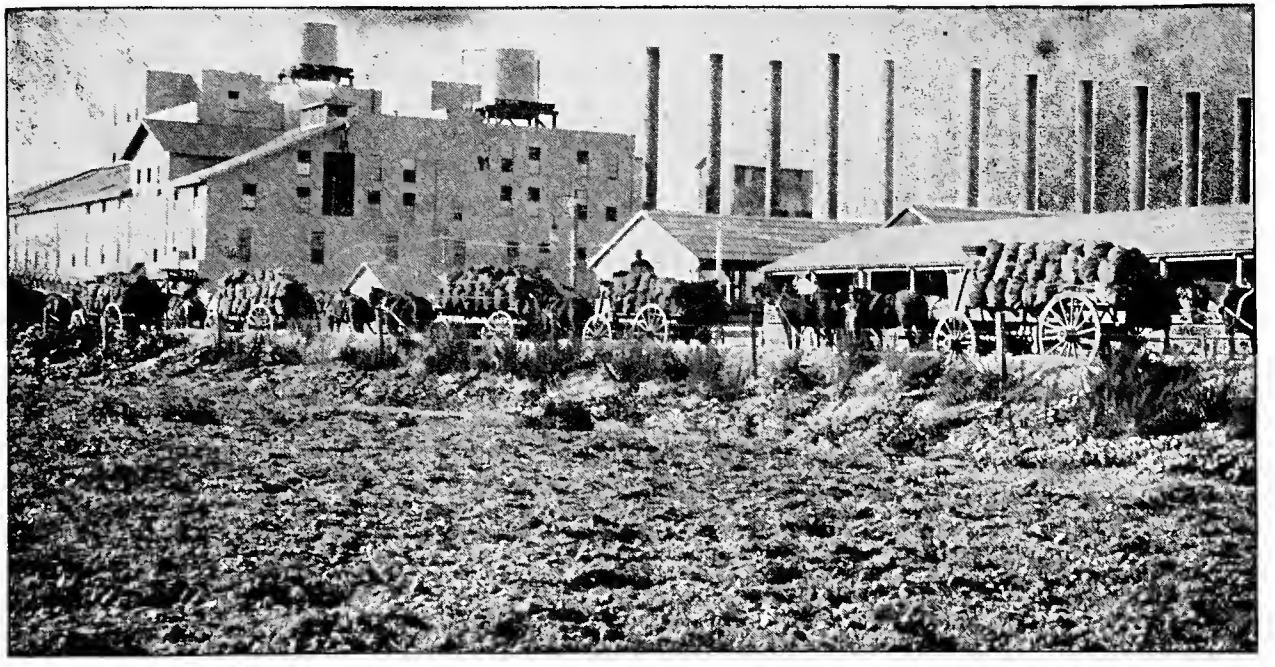
ALL THESE EARLY ATTEMPTS FAILED

for the reasons stated on Page 12 and also because at that time other crops were so much more profitable that farmers would not grow beets, in the culture of which they were wholly ignorant. The then high-priced lands of the east, with the expensive manuring and labor involved in the crop, did not make sugar beets profitable with farmers. The factories, in the east at least, were not located so as to secure a large supply of beets from the immediate neighborhood, and high freights cut down the farmers' returns. The factories were comparatively small, and with a limited supply of beets of uneven or inferior quality, their operating expenses left no margin of profit.

Later, attempts were made to establish the industry in Canada, and a factory was established at Berthierville, Quebec, and another at Farnham, Quebec, but the French Canadians did not have sufficient enterprise to grow the beets, and with mismanagement of the factory, the industry languished in spite of a small subsidy from government. The Berthierville plant was removed to Eddy, New Mexico, in 1896, and the Farnham outfit to Rome, New York, in 1897. The Dominion government encouraged the industry by a direct subsidy of (we believe) one cent per lb, but it was not continued long enough to overcome the indisposition of farmers to raise the beets, although the Farnham enterprise got $44,000 from this source in the years 1892-3, and Berthierville $41,000 in the years '95-6.

AN EXCEPTION--HONOR TO WHOM HONOR IS DUE.

The factory at Alvarado, California, started in 1870, is the first sugar factory which



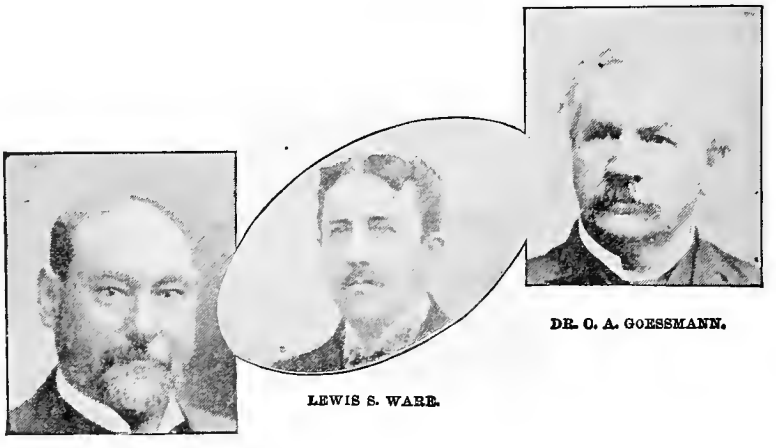
THE FATHER OF AMERICA'S BEET SUGAR FACTORIES.

This is a partial view of the Alameda sugar company's factory at Alvarado, California. It fully deserves the above title. It was built in 1879 by E. H. Dyer, with his son E. F. Dyer and nephew H. P. Dyer. Previous similar efforts had failed. Alvarado was long the only beet sugar factory in the United States, and it was not until 1888 that the Spreckels factory was built at Watsonville, Cal., followed by the Oxnard factory at Grand Island in Nebraska. This pioneer factory at Alvarado had a checkered career in its early days, but is now so successful that in 1897 its capacity was doubled, and now its managers are building a much larger mill in San Luis Obispo county. Too much credit cannot be given to the Dyers and to Alvarado as the "fathers" of the now promising beet sugar industry.

has continued its existence to the present time. Its machinery came originally from the failures in Illinois and Wisconsin. The Alvarado enterprise struggled along for years, while the farmers were learning how to grow beets, and while the quality of beets was being improved. Too much credit cannot be extended to E. H. Dyer, and his son, Edward F. Dyer and others, for their persistent work at Alvarado.

Dr. C. A. Goessmann, a German sugar expert, conducted the first scientific experiments in sugar beet culture at the Massachusetts Agricultural College, 1873-6. Had Goessmann's teachings been followed, the present condition of our American beet sugar industry might have been reached ten or twenty years earlier. Lewis Ware founded the journal, "*The Sugar Beet*," in 1880, having previously revived the Alvarado factory, was instrumental in starting the factories in Maine, Massachusetts and Delaware, has devoted time, brain and money to developing the industry, and deserves full credit.

Dr. H. W. Wiley, chief of the division of chemistry, United States department of agriculture, when in charge of the sorghum work, as early as 1884 investigated the sugar



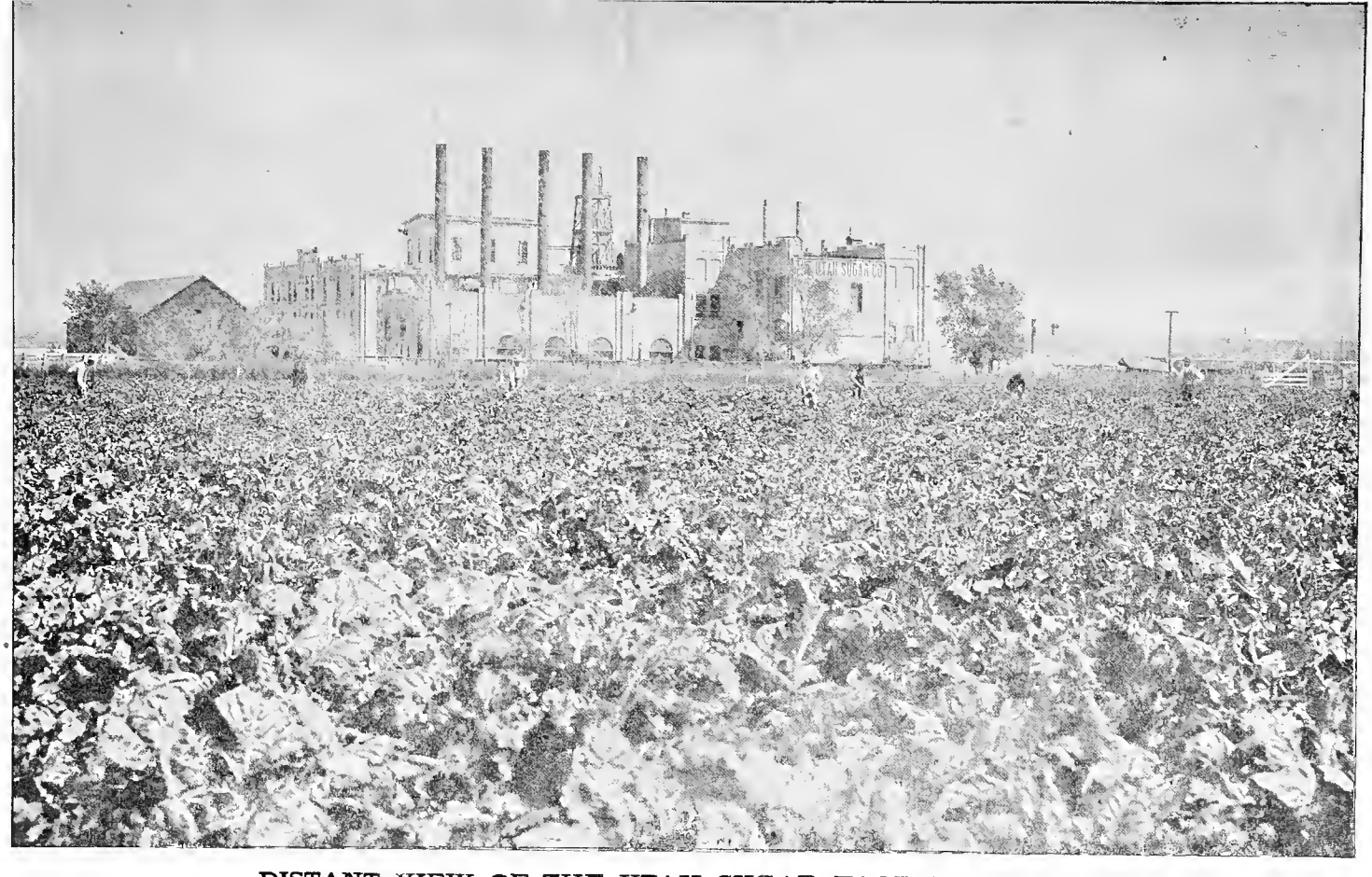
DR. C. A. GOESSMANN.

LEWIS S. WARE.

DR. H. W. WILEY.

beet in California and reported favorably upon it. In 1883 he urged that stations be established to experiment with beet, cane and sorghum, but was not allowed to carry out his plans until 1888-92. Since then the department has actively promoted the industry.

The real impetus given to the beet sugar industry as a practical commercial enterprise in the United States dates from the time the Oxnards took it up late in the '80's. After large experience in the cane sugar and sugar refining interests in the United States, Mr. Henry T. Oxnard made a special study of beet sugar abroad, and became convinced of its possibilities here. With characteristic energy, enthusiasm and ability, Mr. Oxnard spared neither labor nor money in conducting a grand campaign of education, in the course of which he has expended largely of his private fortune. He was also the organizer of the American Beet Sugar Manufacturers' Association in 1891, and as its president has served without salary and mainly at his own expense. Mr. Henry T. Oxnard has backed up his faith with immense investments in sugar factories, by giving away many tons of beet seed, and is to-day the recognized head of the industry in the United States. With the aid of his brother, James G. Oxnard (a sugar engineer of large practical experience), James G. Hamilton and others, the favorable legislation



DISTANT VIEW OF THE UTAH SUGAR FACTORY AT LEHI,

A few miles south of Salt Lake City. A large field of beets in the foreground, nearly ready to "lay by." Snow-capped mountains in the rear. Equipped exclusively with American-made machinery.

of 1890 was obtained, and the great beet-sugar factories at Chino, Grand Island and Norfolk were built by different companies, of all of which Mr Henry T. Oxnard is president. During 1896-7 he has been indefatigable in political circles and at Washington to secure a fair chance for the industry against foreign competition. He has now organized a construction company through which to give the full benefit of his experience, and of the body of trained experts associated with him, to those who contemplate building or operating beet-sugar factories.

RECENT DEVELOPMENT.

Results at Alvarado finally attracted the attention of Claus Spreckels, the Hawaiian cane-sugar king. Thoroughly informed upon the beet-sugar industry in his native country (Germany), Mr Spreckels realized three things: (1) That it was only a question of time before the United States would abrogate the one-sided reciprocity treaty with Hawaii that was making him immensely wealthy; (2) that there was no reason why this country should not produce its own sugar, California offering ideal advantages; and (3) that in the battle for supremacy the beet is destined to win. With his usual keen business judgment, Mr Spreckels erected a small beet-sugar factory at Watsonville, which turned out about 1000 tons of sugar from beets grown in 1888. The plant was enlarged in time to profit by the McKinley bounty, and has gone on with uninterrupted success until it converted into sugar more than 160,000 tons of beets grown in 1896.

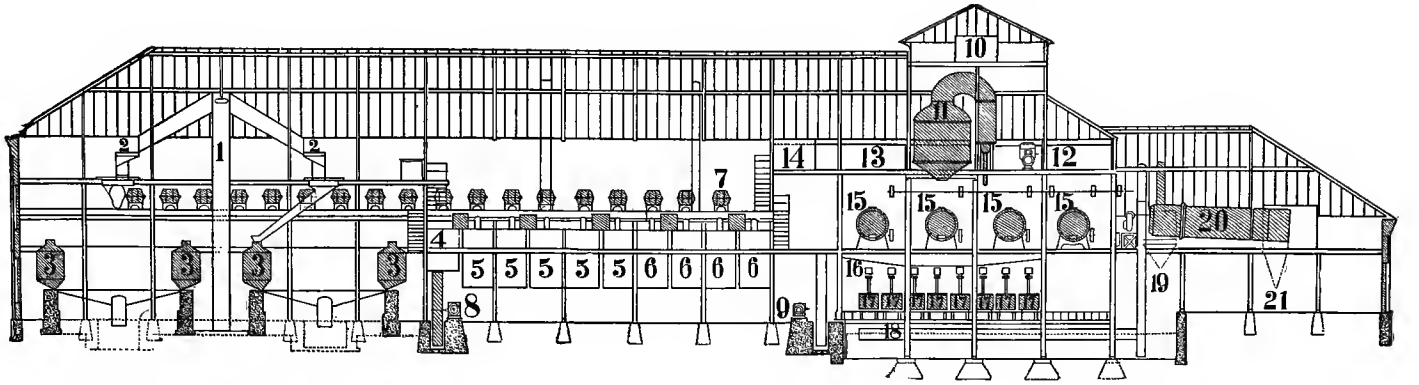
The Oxnards established the great beet-sugar factory at Chino, Cal, in time to work up the 1891 crop, and in the campaign of 1895 it handled 83,000 tons of beets. The Oxnards had the sugar factory at Grand Island, Nebraska, done in time to work up 4500 tons of beets grown in 1890, and it converted about 25,000 tons of the '96 crop of beets into sugar. The same interests built the factory at Norfolk, Nebraska, which worked 8000 tons in its first (1891) campaign, and upward of 50,000 tons in 1897.

Local capital and the characteristic enterprise of certain men prominent in the Mormon church, led to the establishment of the factory at Lehi, Utah, which handled nearly 10,000 tons of beets in its first campaign (1891), and nearly 45,000 tons of the 1896 crop. O. K. Lapham also established a small plant at Staunton, Virginia, that demonstrated the practicability of the industry, but was burned in 1894. The factory at Eddy, New Mexico, was got in operation in time to work up a few thousand tons of the '96 crop, and the same can be said of the new plant at Menomonee Falls, Wis.

THE RECORD IN BRIEF.

Such is an outline of the beet-sugar industry in America to the opening of 1897. The bounty of two cents per pound for fifteen years offered by the McKinley tariff, Aug 6, 1896, gave a great stimulus to an industry which years of extensive and costly experimenting had shown could be developed in this country. But before much could be done, progress was arrested by the Wilson tariff, Aug 28, 1894, removing the bounty and substituting a duty of only 40 per cent ad valorem, with constantly decreasing prices, due to the unfair competition of European export-bounty-fostered sugars.

As usual, it took the farmers several years to learn how to grow beets, and it was not until 1896 that these factories were supplied with all the beets they could possi-



ARRANGEMENT OF THE LATEST IMPROVED BEET SUGAR FACTORY IN AMERICA.

The Los Alamitos factory, near Los Angeles, California, is now (1897) being erected, and will be ready to work up this year's crop, as described later on. Key to numbers in above sectional view: **1.** Beet elevator. **2.** Beet cutter—The beets are cut into ribbands by ten revolving, V-shaped knives. The sliced beets, called cossetts, are delivered by a revolving spout into (3) diffusion batteries, each consisting of 14 cells. Each cell holds 2½ tons of cossetts. Hot water is forced from one cell to the other and after passing through nine cells the water has become of the required density, and is then forced to the measuring apparatus. The cossetts are discharged from the bottom into the hopper-like foundation, and pass to the pulp press through the opening shown on the far side. **4.** Receiving tank. **5.** First carbonators—The juice from the measuring apparatus is here treated with milk-of-lime, and then precipitated by carbonic acid gas. **6.** Second carbonators, practically the same process as in the first, but the alkalinity is brought lower. **7.** Filter presses—Juice is here forced through a finely woven burlap, which collects the impurities precipitated by the carbonic acid gas. **8.** Engine that drives beet department. **9.** Engine that drives sugar department. **10.** Tank to supply the diffusion battery. **11.** Strike pan—The concentrated juice from the evaporators is boiled under a vacuum, to a grain, and is then called massecuite. **12.** Air pump to remove the air and gases from the strike pan. **13.** Tank to hold concentrated juices, preparatory to being worked in the strike pan. **14.** Water tank. **15.** Crystallizers—Apparatus by which a larger yield of sugar is obtained than by the common method of working the massecuite direct from the pan; consists of thoroughly and uniformly agitating the mass of massecuite under treatment, and a delicate and timely control of the temperature. **16.** Mixer—Device to keep the massecuite from solidifying while waiting to be treated by the (17) centrifugals. These are rapidly revolving perforated drums, by which the syrup is thrown through the perforations and the sugar crystals are retained. The conveyor (18) collects the sugar from the centrifugals and delivers it into the (19) elevator. Thence it passes to the (20) sugar dryer, and then to the (21) barrel packers, when the refined granulated white sugar is ready for market. The designing and construction of the buildings and machinery was done by E. H. Dyer & Co., who also furnish the entire equipment, the machinery being made for them by the Kilby Manufacturing Co., so that the entire enterprise is American throughout.

bly work into sugar. This season was a disappointment at Chino, where the expected crop was considerably curtailed by drouth. At Lehi, on the other hand, too many beets were grown—the factory could hardly work them all. We are under obligations to Willett & Gray for the following.

SUMMARY OF BEET SUGAR PRODUCTION IN THE UNITED STATES:

[In tons of 2240 pounds.]

1830,	A few hundred pounds	1884,	953 tons
1831-7,	None	1885,	600 tons
1838-9,	1,300 lbs	1886,	800 tons
1839-62,	None	1887,	255 tons
1863-71,	300—500 tons per annum	1888,	1,910 tons
1872,	500 tons	1889,	2,600 tons
1873,	700 tons	1890,	2,800 tons
1874-7,	Under 100 tons per annum	1891,	5,359 tons
1878,	200 tons	1892,	12,091 tons
1879,	1,200 tons	1893,	20,453 tons
1880,	500 tons	1894,	20,443 tons
1881-2,	Less than 500 tons	1895,	30,000 tons
1883,	535 tons	1896,	40,000 tons

WHAT OF THE FUTURE?

Wherever factories have been established, farmers are now eager to raise beets for them at $4 to $5 per ton. Offers have been made to grow beets for the older factories in 1897 far in excess of their capacity. Watsonville could not accept half the acreage offered. In such cases, the factories contract only with those growers who have shown the most interest and the ability to furnish beets of the best quality.

Mr Spreckels has under construction at Salinas City, California, what is destined to be the largest single beet sugar factory in the world, with a capacity of over 300,000 tons of beets during a campaign of about 100 days, that will be ready for the 1898 crop, and will require 25,000 acres of beets for its supply. At Alamitos, California, a new factory will be ready for 1897 with a capacity of 350 tons of beets per day. The first New York Beet Sugar company hopes to have the machinery from the plant at Farnham in operation at Rome, New York, in time to handle 30,000 tons of the 1897 crop.

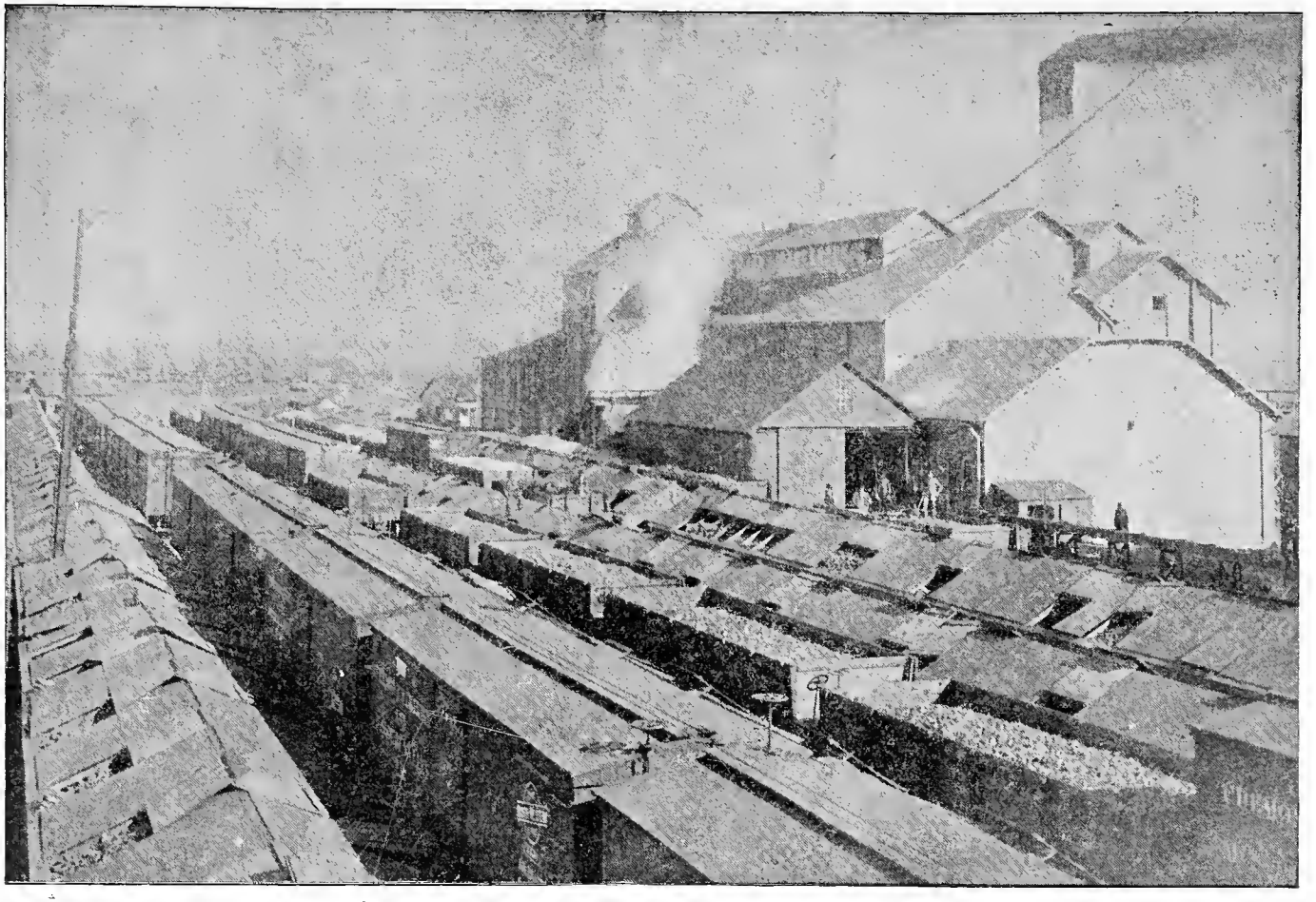
Several of the existing factories propose to enlarge. There are a number of other factory enterprises that are more or less organized. About 1000 communities in the cane and beet sugar belts are anxious to secure beet-sugar factories or cane-sugar houses. There is no question about the prompt and extensive development of the industry, if congress extends to it satisfactory assurances that the American market will be preserved for the American sugar producers. Without this, the business will stop right where it is.

ELEMENTARY PRINCIPLES.

Before proceeding to give details of just how the foregoing has been accomplished and a full discussion of what has been learned from all past experience that may guide us in the future, a few elementary points should be understood.

TECHNICAL TERMS EXPLAINED.

Prof W. A. Henry covers this point very clearly in these words: What is meant by "per cent of sugar in the juice" and by co-efficient of purity? A hundred pounds of sugar beets contain about 95 pounds of juice. This juice not only contains sugar



DELIVERING BEETS BY RAIL TO THE SUGAR FACTORY AT NORFOLK, NEBRASKA.

but various other substances, largely mineral matter, which are a great hindrance, causing serious losses of sugar during the manufacture. A hundred pounds of average beet juice will carry about 15 pounds of solid matter, of which twelve pounds may be sugar, and three pounds matter not sugar. If we divide the number of pounds of sugar (12) by the total pounds of solid matter (15), we get .80, which sum is called the co-efficient of purity; that is, beet juice with 15 parts solids, 12 of which are sugar, is said to have a co-efficient of purity of 80. If the sample of juice contains 16 parts solid matter and 12 parts sugar, as before, then the co-efficient of purity is only 75.

When reducing the beet juice to make sugar, each pound of foreign matter, not sugar, keeps at least one pound of sugar from crystallizing. This true, we see at once that the manufacturer desires beet roots not only carrying much sugar but also with a high co-efficient of purity. Immature beets, those grown on soils rich in vegetable matter or fertilized with fresh barnyard manure, those grown on land recently cleared from the forest, or on drained swamp lands, are all liable to carry a great deal of solid matter not sugar in the juice, and consequently are quite unsatisfactory to the sugar manufacturer. Large beets are likewise always poor in sugar. The leaf stems of the beet, as well as the crown of the beet root itself, also carry much foreign matter. In practice, the manufacturer recovers about 7 out of every 10 pounds of sugar contained in the beet root.

It should be added that the apparent co-efficient of purity of the juice is frequently misleading, since it takes no account of the nature of the non-sugars present. The real purity of the beet is also to be distinguished from the apparent purity of the juice. The real purity of the beet is obtained by dividing the percentage of sugar in the beet by the total solid matter therein; the apparent purity of the juice by dividing the percentage of sugar therein by the apparent percentage of solids as indicated by the Brix spindle.

QUALITY OF THE BEET SUGAR.

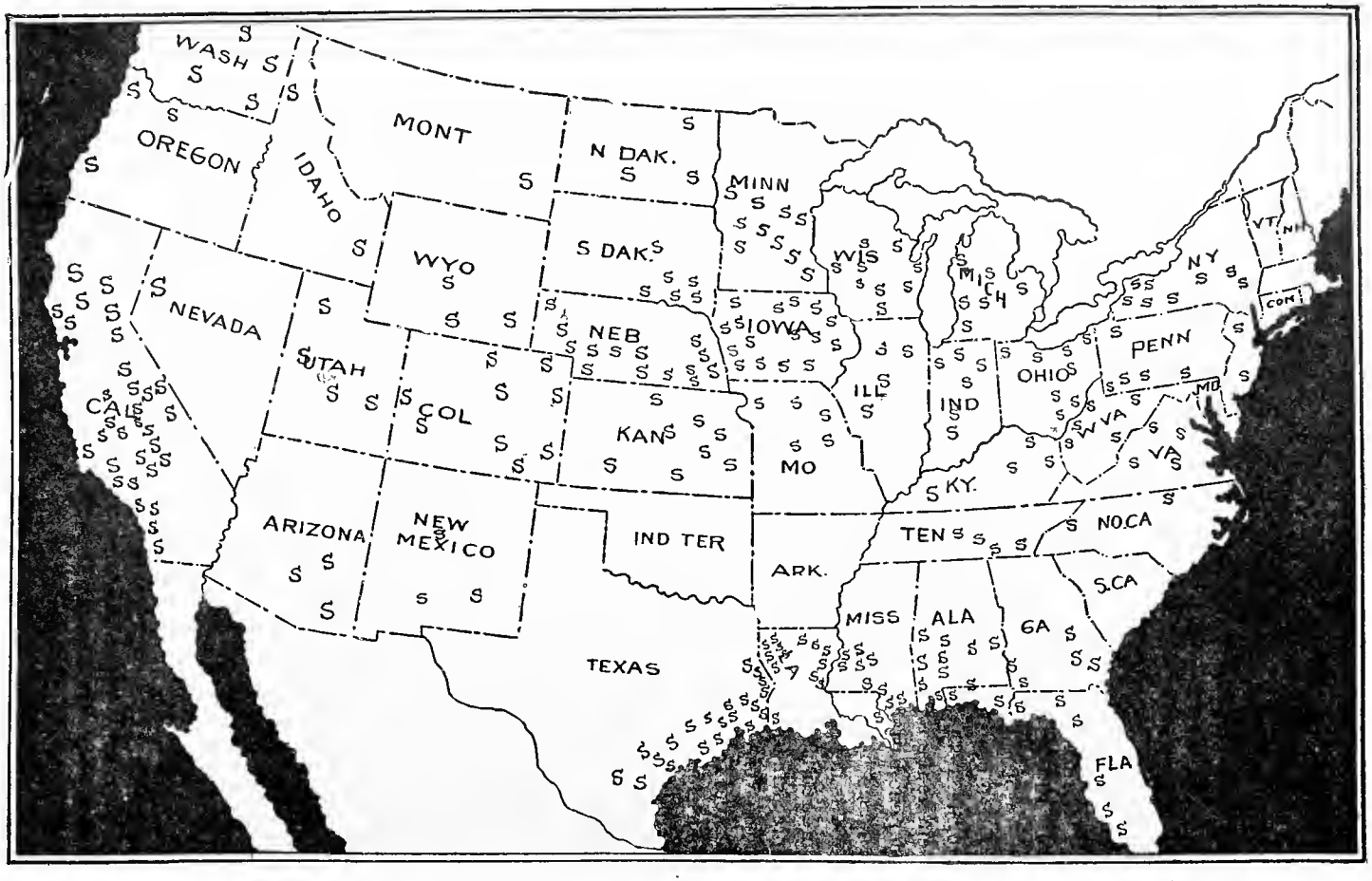
Whenever the subject of beet sugar is brought forward the first inquiry usually made is, "Is beet sugar white like other sugar and does it not have a peculiar taste?" In its very beginning, when struggling for recognition in Europe, the beet industry was handicapped by the claim that its sugar was not equal in quality with that yielded by the cane plant of the tropics. England did not wish to recognize any competitor with the cane sugar of her dependencies. In brief, to answer the questions asked above, the refined sugar from the beet root equals in all particulars that yielded by the cane plant. Enormous quantities of beet sugar are now being shipped to this country from Europe, mainly Germany, and the chances are more than even that the persons who question the purity and flavor of beet sugar are using it daily in their tea and coffee.

HOW BEET SUGAR IS MADE.

The large illustration on Page 30 gives an admirable view of the interior of the Chino beet-sugar factory, which will help to make clear this description of the process of manufacture. First, the beets are brought in by the farmers and deposited in large sheds with V-shaped bottoms, which are connected with the factory by means

of channels, through which a moderate flow of water carries the beets into the first washing machine. By means of a spiral, the beets are tumbled about, washed and carried on until they drop into an elevator, which carries them to the top of the building, where they pass through an automatic weigher and are sliced in such a manner as to open up the pores of the beet as far as possible. The sugar beet is very similar to the honeycomb, and in its little cells is secreted the sweet matter, so that in slicing, it is desirable to open up as many of these little cells as possible. Hence the necessity of having the knives sharp, so that the cells may not be ruptured, but clean cut. As these slices come from under the cutter, they are put in what is known as a diffusion battery, shown in the center of the foreground of illustration on Page 30. In this battery, the sugar is extracted by soaking the sliced beets in water. Warm water is turned into the contents of a large iron jar holding several tons of sliced beets. This water circulates through the mass of cossettes (the name given to the slices of beets) and passes out through the bottom by means of a pipe which enters the top of Jar No 2, the water being forced along by pressure.

From one battery to another, this liquid passes along until it has gone through 14 cells or jars, when it is shown that sufficient water has passed through Jar No 1. The water is now turned off and No 2 becomes No 1 and No 1 is emptied of its cossettes and refilled, becoming No 14, and so the circle is continued all day and all night, procuring in this way all the sugar in the cossettes in liquid form, which now has the color of vinegar. This liquid is now taken to a measuring tank near by from which it goes to a mixer, where it is mixed with lime and then put into a huge tank for carbonation, in which the lime and all foreign matter it contains is rendered insoluble by means of carbonic acid gas forced through the bottom of the carbonation tank. Then the mixture comes through the filter press room where, by means of an elaborate series of frames, it is filtered, and becomes transparent. The process of mixing, carbonating and filtering is then repeated for the second time. This finished, the syrup is treated with sulphur fumes and then passes into the quadruple effect, which is four large boilers in which the water contained in the syrup is evaporated, when we have what is called "thick juice." This syrup is boiled in the vacuum pan, and now becomes raw sugar, and is then run into the centrifugals and made into white sugar. The sugar is now damp, like wet snow, and by means of a granulator, it is dried, and through different sieves is separated into the finer or coarser-grained sugar, ready for the market.



THE LETTER S INDICATES LOCALITIES THAT WANT SUGAR FACTORIES.

In many of these sections organizations have already been started to promote factory enterprises. It is impossible to indicate upon so small a map the thousands of places at which farmers want to raise this new crop. Many localities not indicated hereon are anxious to secure factories.

CHAPTER II.

HOW THE INDUSTRY HAS GROWN IN EACH STATE.

CALIFORNIA.

The Golden State is on the eve of an enormous development of her beet-sugar industry. The remarkable success of this industry in recent years has stimulated both capitalists and farmers to push this new industry to the utmost in case the American market is reserved for American sugar. Experiments in many parts of the state have been conducted extensively during the past six years. In many of these cases, the beets have been raised on a large scale and shipped to existing factories, some being hauled long distances. In other cases, the crop has been used as feed for stock while the farmers were learning how to raise the crop, and demonstrating the adaptability of the sugar beet to their peculiar soil by having the beets analyzed at the state experiment station. It is now evident that there are hundreds of square miles of the richest land in the world available for sugar-beet culture in the Golden State.

PRESIDENT ALLEN.

R. M. Allen, president of the American sugar growers' society, is also president of the Nebraska state sugar growers' society and one of the largest growers of sugar beets in the country, having grown 500 acres of beets annually for the past six years. He is also a large cattle feeder and is profoundly impressed with the vast possibilities of the beet sugar industry and of the great value in cattle feeding of the beet pulp from the factory and of the beet tops.

The factory of the Alameda sugar company, at Alvarado, will probably be enlarged this year. During the campaign with the 1896 crop, it has worked up about 55,000 tons of beets. Their sugar content varied from 12 to 18 per cent, with from 70 to 88 per cent co-efficient of purity, averaging over 15 per cent of sugar and 81 purity. We give on Page 33 an excellent photo-engraving of this historical pioneer factory.

In the 1895 campaign Alvarado worked 27,385 tons of beets into 5,400,000 lbs of sugar, the beets averaging 13 per cent of sugar.

MR SPRECKELS' ENTERPRISE AT WATSONVILLE

in Santa Cruz county, near the coast, about 75 miles south of San Francisco, and 25 miles north of Monterey, has the credit of standing at the head of the sugar industry

in America, working up in a single season the largest quantity of beets, and turning out the largest quantity of sugar ever made by one factory in this country. As high as 1400 tons of beets have been crushed by the factory in one day of 24 hours, also the American record. The campaign of 1896 began in September and concluded on January 29, beets being delivered by the farmers up to Jan 23. There were 154,936 tons of beets delivered to the factory by rail and wagon, from which 19,528 tons of sugar were made during the campaign of 171 days, the factory running 3446 hours—the longest run on record in this or any other country. This plant does not refine its product, the raw sugar being shipped to the Spreckels' refinery at San Francisco, which accounts in part for the large capacity of this factory.

It is not likely that this phenomenal record will soon be duplicated by this or any other factory. The conditions were about as near perfect as could be, both in field and mill. The phenomenal crop of 1894 was beaten by about 10,000 tons by the crop of 1896, but the quality was much higher, as 7000 more tons of sugar were obtained the past season than in the 1894-5 campaign.

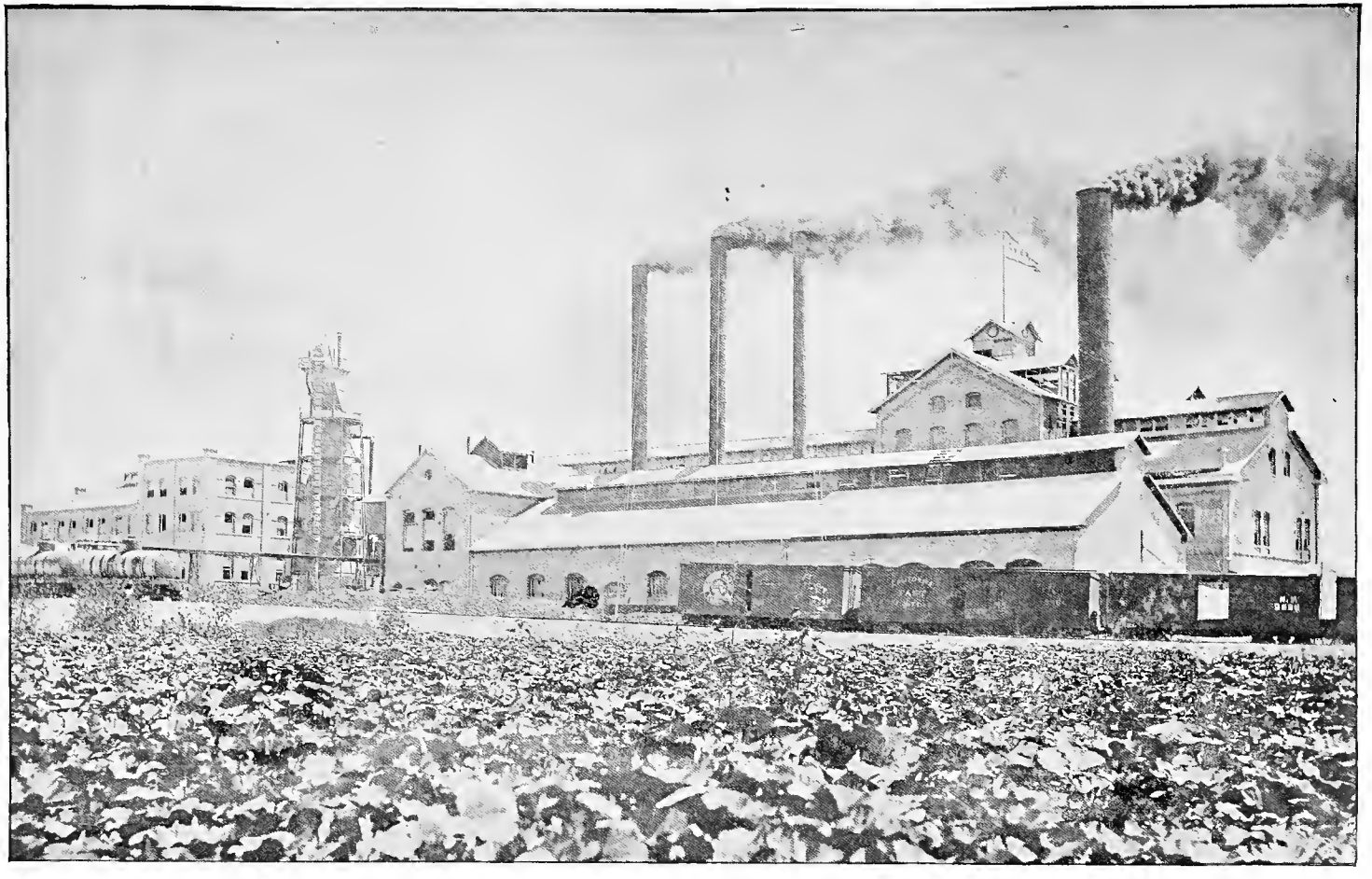
The 155,000 tons of beets were grown on about 11,017 acres, yielding an average of 14 tons of beets, and 3,545 pounds of raw sugar per acre. Some fields gave as high as 25 tons per acre, and small plots of a few acres ran up to 30 tons, while several tracts of 100 acres or more averaged 18 tons per acre. Fully 12,000 acres have been contracted for the '97 campaign, indicating a probable crop of 150,000 tons.

In the campaign of 1895, the Watsonville factory ran 2063 hours, sliced 77,145 tons of beets or an average of 900 tons per day of 24 hours. From these beets 10,945 tons of sugar were manufactured. The beets were produced on 7244 acres, which averaged nearly 11 tons of beets and 1½ tons of sugar per acre. This is a smaller yield than in previous years, because of extensive rainfall during the harvest period.

The Watsonville factory pays $4 per ton for all beets, or a total paid farmers for the '96 crop of nearly $650,000 compared to $300,000 for the crop of the previous year. Since its humble beginning upon the crop of 1888, this concern has paid the farmers about $2,500,000 for beets—a new crop that but for this factory would not have been grown. More than half a million has been paid for labor in this factory. In brief, this enterprise, in a little more than eight years, has distributed some $3,000,000 among the farmers and laborers of this vicinity—money that otherwise would have gone out of the country to pay for imported sugar. This money and the industries its circulation has created, have built up a remarkably prosperous community, where farmers were prosperous and money was easy all through the hard times of 1893-6. Whole pages could be filled with the particulars of the beneficent results of the industry, especially in view of the fact that but for it these farmer would have been obliged to raise grain or fruits at little or no profit. Many of them have paid off their mortgages and acquired a snug little competence besides from the beet crop. Says the local paper, the Pajaronain of Jan 21, 1897: "The beet payday last week was a giant and twenty-dollar pieces crowded each other in Watsonville. There was about as much money paid out here that payday as the railroad company pays out monthly at its big shop center, Sacramento; and the next payday will be about as large."

EXPERIENCE IN SOUTHERN CALIFORNIA.

The enterprise at Chino in San Bernardino county in Southern California, is in



PARTIAL VIEW OF THE MODEL BEET SUGAR FACTORY AT CHINO, CALIFORNIA.

many respects typical of what the sugar industry can do for a community. A few years ago this was a vast ranch, which Richard Gird had purchased and conducted as a cattle and horse-breeding establishment, on the liberal scale characteristic of California's early days. With the decline in live stock, however, Mr Gird recognized the necessity of devoting his property to the production of some crop that could be utilized at a profit in the vicinity. Instead of going into citrus fruits or other specialties already established in that region but in which he feared overproduction, he looked into the beet-sugar industry, raised beets for a number of years on various soils, determined their sugar content, and in due time was able to demonstrate that on this spot could be raised the largest yields per acre of beets richest in sugar. All this involved a vast amount of original and costly work, and thus it took two or three years to find capitalists and get them sufficiently interested to put up the money needed. The outcome was the establishment by the Chino Valley Beet-Sugar Company of the immense plant illustrated in part on Pages 30, 45 and 47, in which the Oxnards are the controlling spirits.

Mr Gird had to contract to furnish the factory with at least 5000 acres of beets for several years—and this at a time when there was not another house to be seen from the homestead on the vast ranch. But with a market assured for a new, certain and profitable crop, Mr Gird at once offered liberal inducements to settlers, land was sold in small blocks on easy terms, people flocked to Chino, until it has now become a thriving community in a well-built town, surrounded by farms of from 10 to 30 acres or more, each with its comfortable home and well-to-do family. All this where cattle and horses roamed the unbroken prairie previous to 1890. And so well was the enterprise conducted that when Mr Gird wished to retire in 1896, he was able to sell the balance of the ranch to an English syndicate for $2,500,000.

The factory really began operations in 1891, when less than 2000 acres of beets were grown, and the average yield was only seven tons per acre, or a total product of 13,000 tons, for which the farmers were paid about $51,000. During the season of 1895, five thousand acres in this township were devoted to beets, while the product from 2500 acres more were hauled by rail about 75 miles from the Orange county district. The factory that year converted 83,000 tons of beets into sugar, for which the farmers were paid nearly $362,000. Most of the beets are grown within two miles of the factory, the longest wagon haul being eight miles, and the shortest half a mile. Over twenty million pounds of refined sugar was actually made and sold, exclusive of a little raw sugar and all molasses, etc, or an average of 249 lbs of refined sugar obtained and sold from each ton of beets, or 2747 lbs from each acre of beets. The land about the factory is peculiarly fitted for this industry, as seed can be planted very early on the uplands, and then in succession on the lower lands. Thus the factory can begin to work up the early crop in July, and in the absence of frost can run until the latest seeding is harvested in November. All pitting and storing of beets is thus saved—a most important consideration. The season of 1896 was the dryest in 20 years, but the factory milled 63,000 tons of beets before closing down about Nov 1, part of the crop not being accepted. Chino fields furnished nearly 50,000 tons. With the usual rainfall, 80,000 tons of beets was to have been expected. The full details of the last campaign are not available at this writing, but here is a table giv-

This building at the left is for the Steffens process of refining.

Large piles of broken limestone in the foreground.

Three more large kilns under cover to the right.

LIME KILNS AT CHINO BEET SUGAR FACTORY

ing an immense amount of information about the industry and its growth.

THE RESULTS AT CHINO FOR ITS FIRST FIVE YEARS.

	1891	1892	1893	1894	1895
Acres of beets grown,	1,800	3,488	4,191	4,778	7,528
Tons of beets produced,	13,080	26,266	49,353	43,773	83,035
Average yield of beets per acre, tons,	7.26	7.53	11.7	9.16	11.03
Per cent of sugar in beets,	13	14	14	15	15
*Crude sugar per acre, lbs,	1,888	2,100	3,276	2,748	3,309
*Pure sugar per acre (80%),	1,510	1,680	2,621	2,198	2,670
Began making sugar,	Aug 20	July 13	July 31	Aug 2	July 9
Finished making sugar,	Oct 31	Oct 11	Nov 4	Oct 24	Nov 14
Days in operation,	73	91	97	85	129
Average weight of beets worked daily, tons,	179	288	509	526	644
Average weight of sugar made daily, lbs,	28,108	86,852	15,592	111,431	161,129
Total weight of sugar made, tons,	1,026	3,952	7,532	4,736	10,393
Average paid farmers per ton beets,	$3.90	4.26	4.26	4.66	4.35
Average return per acre,	$28.37	31.95	49.84	42.69	47.98

*Estimates or data figured by the author, the other facts being all furnished from the company's books. The ton is of 2000 lbs. Granulated sugar only was made in '91, raw sugar only in '92 and '93, while the product of '94 was all the best grade of refined white granulated sugar except 1009 tons (2,017,363 lbs) of raw sugar, and in '95 only 51 tons (102,286 lbs) of raws.

Among the most successful beet growers for this factory are the brothers Gustafsen, who averaged 15 to 20 tons per acre. The Dethlefsen brothers averaged 20 tons per acre on 250 acres in the comparatively poor season of 1896, and will double their area in 1897. They give their crop close personal attention, and no detail that will contribute to success is omitted. They have fully determined that there is a certain profit in intelligent beet culture, and well they may, for their net profits above all expenses and good pay for their own time and ability, have averaged over $30 per acre.

To protect their interests at the factory, planters have a strong union, which chooses its own chemist, weigher and tare man to keep tab on the beets as delivered, to see that full weight is credited on each lot, and that the deduction for tare is not too large, while the chemist's duplicate analyses are a check on the factory tests. At the annual meeting in December, 1896, of the Chino beet growers' union, numbering 106 farmers, it was reported that 48,139 tons beets were harvested and marketed. The average price per ton was $3.78, representing a total of about $180,000 paid for this season's beets. The average sugar content was placed at 14 per cent. In addition to the present membership, there are nearly 100 farmers who make a business of growing beets, and it is hoped these may also be brought into the union, in order to secure the best possible administration of the business affairs of growers. At the beginning of the season an assessment of 4c per ton was levied on all Chino beets to defray factory and office expenses of the union, including tare man and check chemist. The close of the season finds a surplus in the treasury which makes it possible to rebate 1½c per ton. Thus it cost less than 3c per ton harvested to carry on the business of the union.

The Chino factory uses oil for fuel, from 75,000 to 100,000 barrels during a campaign, which comes through pipes from the oil company, 14 miles distant, although it is hoped to get a supply near by from oil wells on the ranch. It consumed 125,000 tons of limestone in 1895, its 21 artesian wells furnished nearly 4,000,000 gallons of

Side view, factory in full operation.

End view.—Late winter after close of campaign.

TWO VIEWS OF THE OXNARD PLANT AT NORFOLK, NEBRASKA.

water daily and it paid $100,000 in wages to the 350 men employed in and about the factory.

THE NEW FACTORIES IN CALIFORNIA.

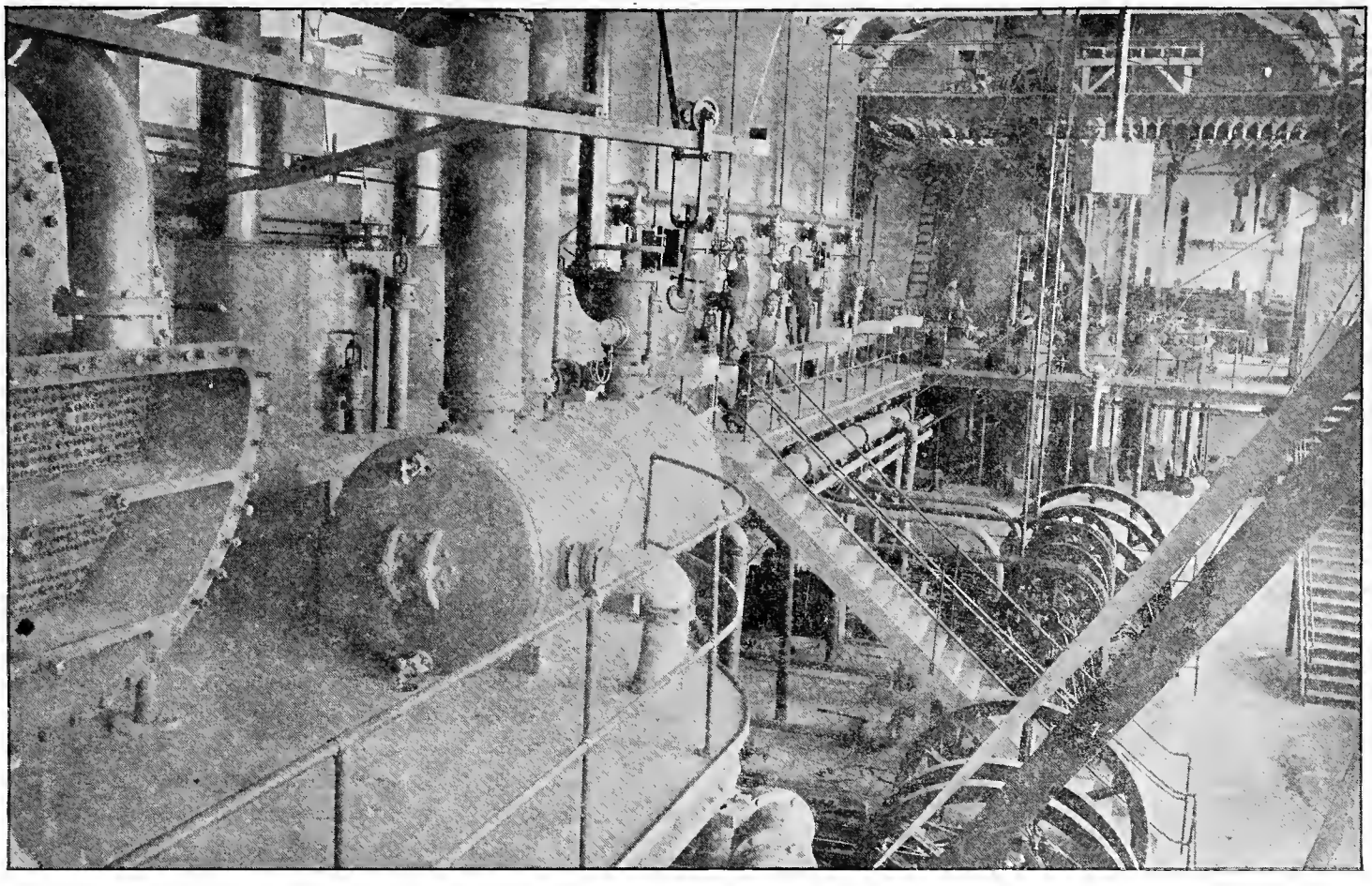
Work is going forward on Mr Spreckels' immense plant at Salinas City. While it will have a capacity of some 3000 tons of beets per day of 24 hours, it will practically consist of three sets of machinery under one roof, each of 1000 tons capacity daily. Mr Spreckels will have to pay out $12,000 a day for beets and $5000 daily for labor and other materials at the factory. According to this estimate, the daily expenses will average no less than $17,000, or nearly $2,000,000 for a campaign of under four months. It was expected at first that this immense plant would be ready for the 1897 crop and before it was decided upon, Mr Spreckels insisted on having contracts with farmers to grow 25,000 acres of beets. It now appears that delays in making the machinery are such that the plant will not be in operation until 1898. While it will use the product from 25,000 to 35,000 acres of land annually, fully 100,000 acres will be involved, in order to permit the necessary rotation of crops. Farmers in the contiguous country, however, are ready to grow 100,000 acres of beets every year if factories are put up to work them.

The Los Alamitos Sugar Co is building a large factory in the center of the Los Alamitos Rancho, which contains 6700 acres of choice sugar-beet land belonging to the Bixby Land Co, which has contracted to furnish the sugar company with its full complement of beets for a term of five years. This ranch lies about ten miles inland from the sea, near Los Angeles. The climate is perfect the year around. The soil is a deep, sandy, sub-irrigated loam, having been deposited for centuries by the overflow of the San Gabriel river, and according to the artesian-well borings, its depth exceeds 400 feet. It is believed that there is sufficient moisture in the soil to produce beets in the dryest years without irrigation. The factory is being equipped entirely with American machinery by E. H. Dyer & Co of Cleveland, Ohio, who furnish both buildings and machinery and turn them over to the sugar company when in full operation. The frame of the factory is of steel and the walls of brick and will be equipped to work off 350 tons of beets per day of the 1897 crop. The building is so large that more machinery can be added to double the present capacity at the minimum of additional expense. Great care has been given to so plan the building and machinery as to secure the utmost economy of labor and fuel. These works will handle 350 tons of beets per day with less than 100 men, and consume under fourteen per cent of lignite coal for fuel. A sectional view of the structure is given on Page 37.

Many of the sugar factory propositions in California are awaiting the action of congress. Should it be favorable, several new enterprises will be established in time to handle thousands of additional acres of beets in '98.

NEBRASKA.

The efforts to establish the beet-sugar industry in Nebraska date back about ten years, and her experience is typical of the obstacles in the way of the industry. A factory was established at Grand Island in 1889, by the Oxnards, being aided by the gift of land and a cash bonus, while the state offered a bounty of one cent per pound on the sugar, which yielded the factory $7,364 on the product of its first campaign on the crop of 1890. The law was repealed at the session of '91. Meanwhile the



INTERIOR VIEW OF A SMALL PART OF THE NORFOLK BEET SUGAR FACTORY.

Showing battery of diffusion cells arranged in a circle on main floor, in background.

Oxnards had established another factory at Norfolk, in the northwestern part of Nebraska, but the farmers were slow to take hold of the industry, and with the repeal of the state bounties and the national elections of '92 forecasting the repeal of the McKinley bounty and lower prices for beets, a decided set back was given to the industry. On top of this came the drouth year of 1894, with disastrous results. The factories having been obliged to reduce the price from $5 to $4 per ton, not enough were planted to run the factories a reasonable length of time, even had the season been favorable.

The state came to the rescue and by the act of March 25, 1895, offered a bounty of ½ of a cent per pound on all sugar manufactured, provided the price of beets was raised from $4 to $5. This bounty therefore amounts to an extra bonus of $1 per ton on the beets to growers. Thus encouraged, 5000 acres were secured for the Norfolk factory and 4000 for the Grand Island factory for the 1895 crop. The spring was not favorable, the early summer was dry, but later fine-growing weather promised a magnificent crop. Then came what the beet planter dreads almost as much as the cane planter fears early frosts: September opened with a general rain followed by a period of high temperature. The nearly ripened beets, responding to the moisture and warmth, began a period of growth, drawing sustenance from the sugar already stored. Before they could again begin elaborating sugar, a period of cold and cloudy weather set in, checking growth and leaving the beets in an immature condition as a result of these unprecedented climatic conditions. The result was that many beets were rejected by the factory because, being below 12 per cent sugar and under 80 purity, it did not pay to work them at $4 per ton. This caused much dissatisfaction among growers, who at first complained that the factory tests were not reliable, but they employed a chemist of their own and also had analyses made by the state experiment station. This work supported and justified the results reported by the factory chemists, and convinced farmers that the fault was in the weather and not in the factory.

But for the determined efforts of the Nebraska beet-sugar growers' association, it is possible that the whole industry might have stopped then and there. As the bounty was supposed to stand for another year, a grand effort was made to give the industry a thorough trial in 1896. The result was all that could be expected. The crop was perfect in every particular, the weather in September, October and November was as usual all that could be desired, and the factories worked up over 75,000 tons of beets. Farmers have made handsome profits on the 1896 crop, they feel that they have thoroughly mastered the culture of the sugar beet, and they offer to grow many more beets for 1897 than the factories can possibly work up, even should the beets be siloed so that the factories can run until March 1, as was the case at Norfolk on the 1896 crop. Growers who had contracts the past year want to double or triple their acreage and hundreds of others are anxious to raise beets on their own lands, or lease lands for the beet crop of 1897. And this in spite of the fact that Nebraska's supreme court has decided that the state bounty (of which $50,000 was paid on the '95 crop) is not payable unless the legislature specifically appropriates the money therefor. Whether the state will pay this bounty of $1 per ton on the '96 crop is not yet settled, but it is evident that the state will not renew the bounty, so that unless na-

FRONT VIEW OF THE OXNARD'S BEET SUGAR FACTORY AT GRAND ISLAND, NEB.

tional legislation and advancing prices for sugar increase its value, the price of beets for 1897 will be not over $4 per ton. That was the price for '96, the extra dollar being conditional upon the state paying the bounty.

THE RECORD OF THE BEET SUGAR INDUSTRY IN NEBRASKA.

The dry season of 1894 produced beets of a low water content that yielded an average of 216 lbs of refined sugar to the ton, compared to 176 lbs the year before. In 1895, on the other hand, late rains and a warm fall started a second growth which increased the size and weight at expense of sugar, which averaged only 150 pounds of refined to the ton. The average for the last campaign will be fully 200 lbs of refined sugar to the ton and will thus compare with previous years since the factory began operations:

	Tons of beets worked			Granulated sugar produced lbs			No of growers		
Year	G I	Norfolk	Total	G I	Norfolk	Total	G I	Norfolk	Total
1890,	4,414	—	—	736,400	—	—	607	—	—
1891,	10,868	8,179	**19,047**	1,415,800	1,318,700	**2,734,500**	408	204	**612**
1892,	13,055	10,725	**23,780**	2,110,100	1,693,400	**3,803,500**	240	490	**730**
1893,	11,150	22,625	**33,775**	1,835,900	4,107,300	**5,943,200**	135	181	**316**
1894*,	drouth	25,633	**25,633**	—	5,556,100	**5,556,100**	—	534	**534**
1895,	24,343	31,194	**55,537**	2,983,400	5,395,500	**8,378,900**	619	698	**1317**
1896,†	75,000	—	**75,000**	—	—	**15,000,000**	—	—	**2000**

*General drouth made tonnage so small in 1894 that the beets belonging to the Grand Island factory district were worked up at the Norfolk factory. † Partly estimated.

The average yield last year was 10 to 12 tons per acre, but some experienced growers on richly manured bottom land had from 18 to 25 tons per acre, and even more. Growers of beets for these factories are more or less scattered over the state, and much of the crop has to be hauled by rail. The freight is 30c per ton for distances of 25 miles or less, 50c for 25 to 45 miles, and 80c for 45 to 100 miles, the rate being a little higher on another railroad, which exacts an additional charge of $2 per car for switching. The cars are loaded to their visible capacity. The factories paid about $300,000 for beets in '96, or $35 to $75 per acre and even more in a few instances. Renters pay $8 to $10 per acre per year for choice beet land.

But for the splendid and persistent work of the Nebraska experiment station (especially H. H. Nicholson), which conducted tests in all parts of the state and made thousands of analyses, and even conducted a sugar school, the present assured position of the business in Nebraska could not have been reached. The station has made 10,000 analyses, the average of all being over 14 per cent of sugar in Nebraska beets. It is now certain that only moisture and proper culture are needed to enable the beet to be grown to perfection in almost any part of the state. There is a great demand for beet-sugar factories in almost every county in Nebraska.

UTAH.

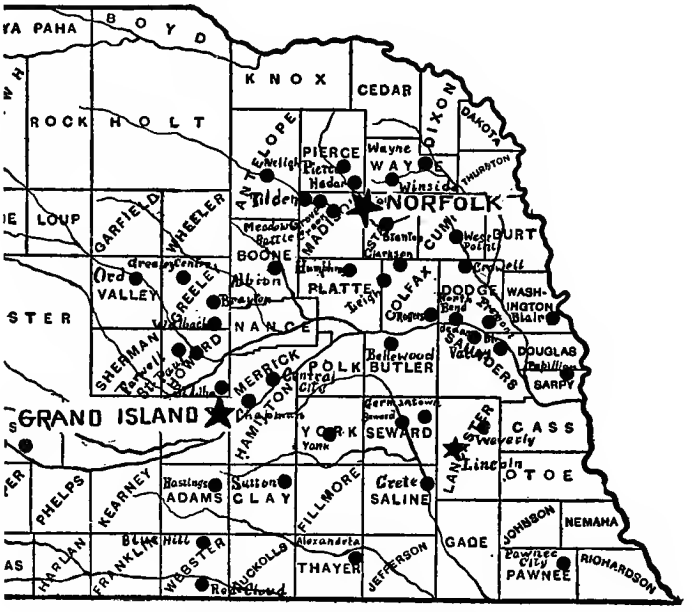
Keen interest is felt in the beet-sugar industry all over this state, owing to the established success of the (at present) only sugar factory in the whole inter-mountain region of the United States, at Lehi, a few miles south of Salt Lake City, Utah. Beets for sugar manufacturing can be ruined by a superabundance of moisture just at the ripening period. As sugar beets can be grown here only by irrigation, the industry at the outset was surrounded by new and peculiar conditions. The knowledge and science of beet growing (it is a science) were obtained from experts from Cali-

THE GREAT BOILER ROOM OF A BEET SUGAR FACTORY.

From a photograph of the plant at Chino, southern California. The fuel is oil, 80,000 barrels being consumed per season to operate the 2,400 horse power engines.

fornia, but they were ignorant of the methods of irrigation, so it required the combined knowledge of the experienced beet growers of California and the skillful irrigators of Utah to successfully produce our first crop of sugar beets. But the problem has been most happily solved, and to-day Utah produces sugar beets that are fast approaching in quality those of the oldest beet-growing countries.

The growing of this plant is a departure from the usual methods of farming as practiced by the ordinary farmer, in that no part of it can be neglected, or even done

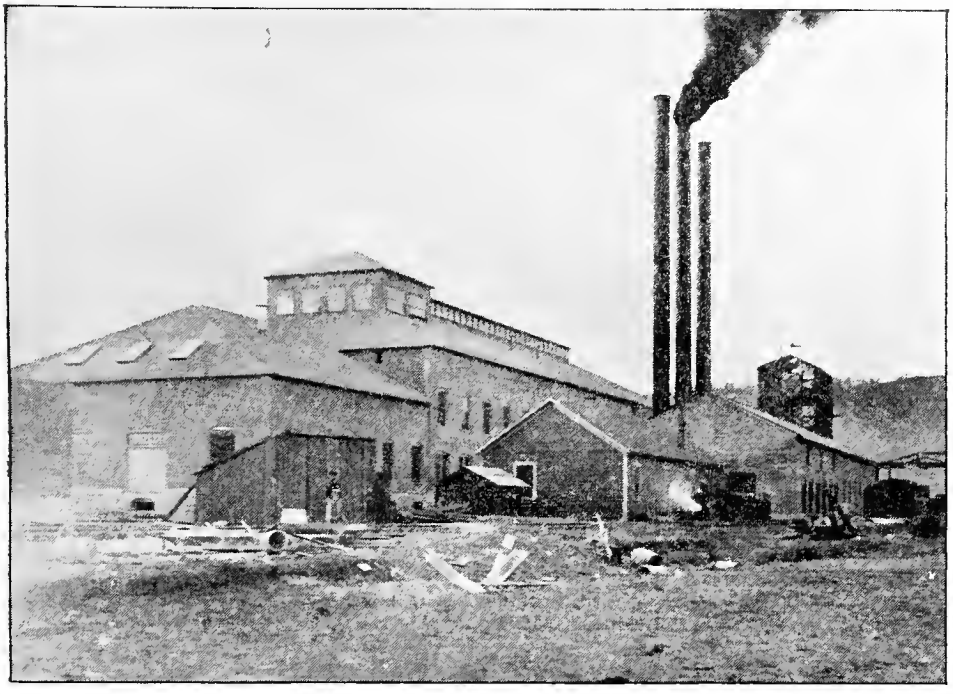


MAP OF EASTERN NEBRASKA

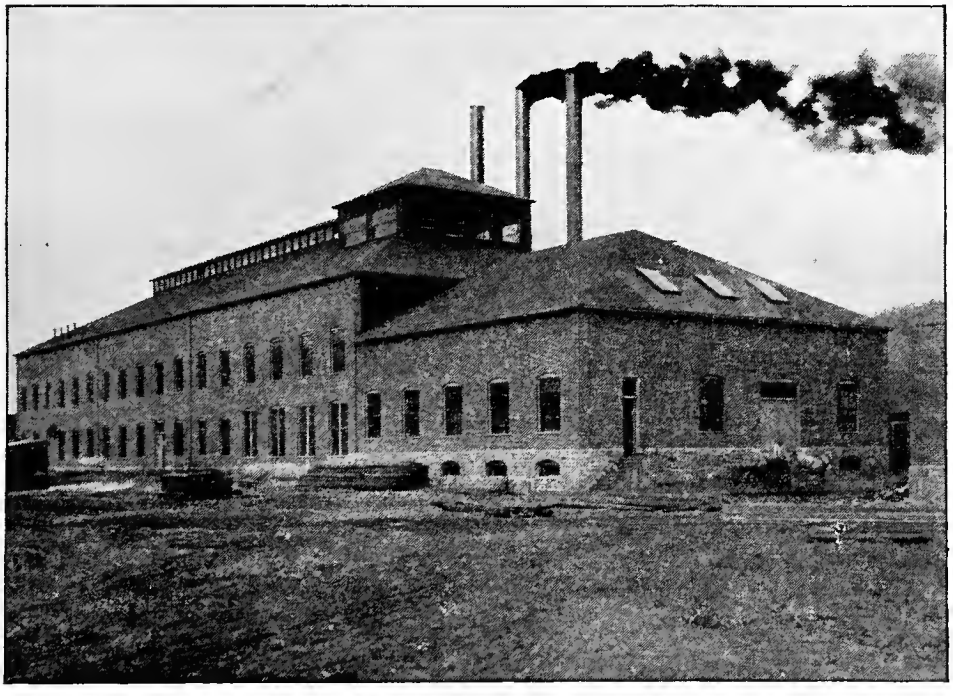
Showing location of the two beet sugar factories at Norfork and Grand Island, and principal points at which beets are grown for shipment. (From Bulletin 44, Nebraska experiment station at Lincoln.)

in a haphazard sort of manner, without sacrificing the crop. It requires intensive cultivation in every sense, but it pays well, a larger cash return being obtained from one acre of beets than from three acres of grain. As the farmers gradually become more familiar with the crop, they steadily increase the yield in tons per acre as well as the sugar quality of the beet.

The farmers of Utah for the first two years took hold of the beet industry cautiously and lightly, preferring to carefully test its merits for themselves before risking too much on a new crop. There were some failures and many successes, but they soon discovered its value, and the increased acreage offered since then has been so great that for the past two seasons the sugar company could not accept it all. At the present writing (March, 1896), there are already applications for over 1000 acres of beets more than can be accepted for the coming season of 1896. During the sugar campaign just closed, the Lehi factory received 33,108 tons of beets from 3300 acres, an average of 11.54 tons per acre; 300 acres averaged about 7 tons, 2000 acres about 11



Machine Shops, Boiler House and Lime Kiln.



Rear View of Main Building.

PICTURES OF OREGON'S FIRST SUGAR WORKS.

tons, while the remaining 1000 acres made about 14 tons per acre of trimmed beets delivered at factory. At $4.25 per ton, the farmers got nearly $162,000 for the crop, from which was made nearly 7,500,000 lbs of refined granulated white sugar. Compared with the previous years the following

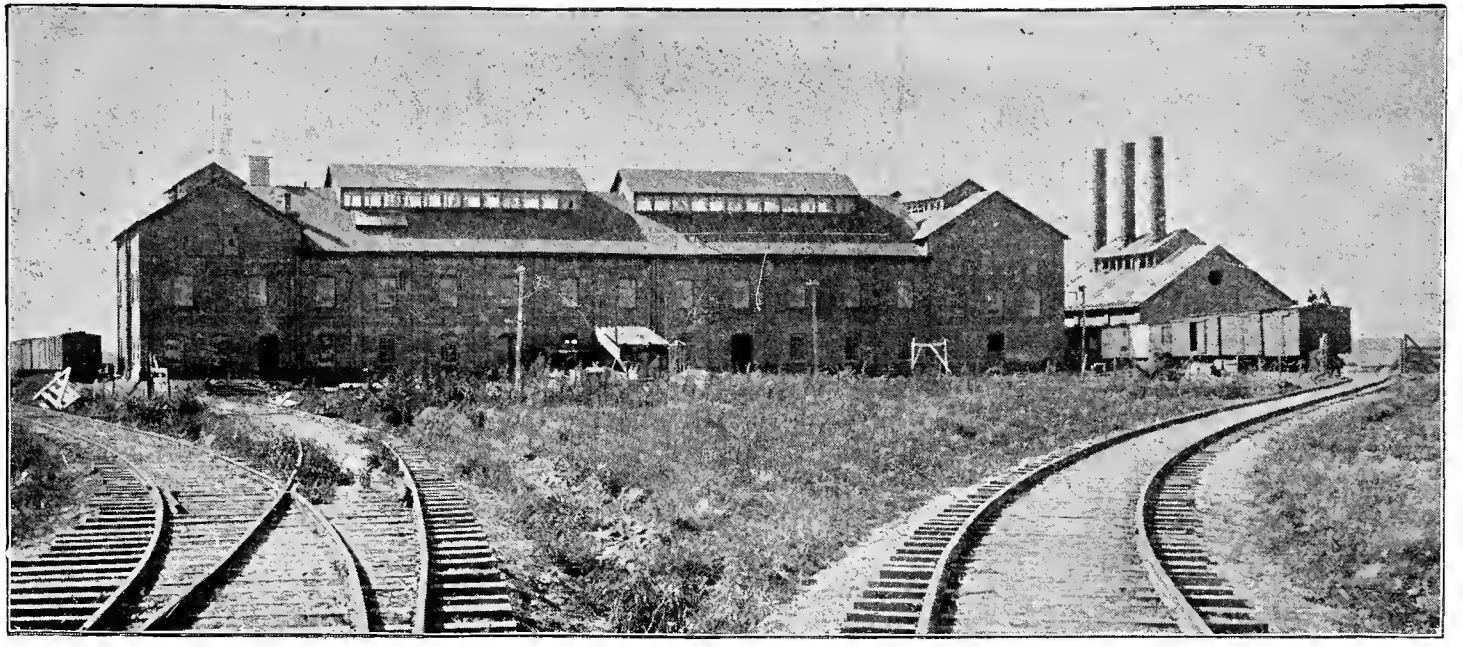
TABLE SHOWS THE PROGRESS OF THE INDUSTRY IN UTAH.

	1891	1892	1893	1894	1895
Acres of beets grown,	1,500	1,500	2,755	2,850	3,300
Tons of beets produced,	9,960	9,816	26,800	32,694	38,108
Average yield of beets per acre, tons,	6.6	6.5	9.7	11.47	11.54
Per cent of sugar in beets,	11.0	11.8	11.6	12.7	13.5
Purity of sugar, per cent,	80.0	80.0	79.5	80.2	81.5
*Crude sugar per acre, lbs,	1,452	1,534	2,250	2,913	3,116
*Pure sugar per acre, lbs,	1,162	1,227	1,719	2,336	2,539
Began making sugar,	Oct 12	Sept 26	Sept 19	Sept 25	Sept 5
Finished making sugar,	Dec 8	Nov 13	Dec 21	Jan 5	Dec 31
Days in operation,	58	49	94	103	118

*Estimates added by the author as matters of interest. About 45,000 tons of beets were worked in 1896, for which $4.25 per ton was paid, or a total of about $190,000; paid for labor at factory about $35,000, for coal $30,000 and for other supplies $25,000.

The methods of manufacture have practically reached the same degree of perfection in the successful factories of this country as they have in Europe, showing that the essential factor for the success of the beet-sugar industry of America is the beet root itself. The factory at Lehi, Utah, was the first one to be planned and constructed by Americans and equipped throughout with American machinery. It certainly has many features of excellence to commend it over the European factories. The machinery of itself is more effective in many ways, and its arrangement is such that there is a saving of at least one-fourth the number of hands required in a European factory of the same capacity. During our campaign of 1895, out of which 113 days were occupied in cutting and working beets, it worked an average of 337½ tons per day, with a factory of only 300 tons guaranteed capacity. As appears from the table above, the length of a beet-sugar campaign is necessarily limited to a few weeks after the harvesting period, for the beets cannot be kept very long without so deteriorating as to be unprofitable for manufacturing purposes, The total yearly expenses, therefore, of an investment of from one-half to three-quarters of a million of dollars, have to be made during a campaign of 90 to 110 days.

The engravings herewith, from photographs taken especially for this work, give an admirable insight into this Utah enterprise. It was projected by men of Utah, who furnished all of the $600,000 invested in the plant, with its 1000 acres of land, with silos and pits for pulp and yards for feeding it to stock. Many shares in the factory are owned among the farmers, and it is in that sense co-operative. The two principal buildings are entirely of brick, the walls being two feet thick, the foundation laid deep, and the piers sustaining the main weight of the machinery being solid masonry resting on bed rock. The main building is 180x84 feet, three stories high. The annex is 184x60 feet. In the latter building are contained ten horizontal tubular boilers, with a generating capacity of 100 horse power each; twenty large char-filters, char kiln with all the necessary apparatus for revivifying the bone charcoal, and the lime kiln, which treats about seventeen tons of lime rock each 24 hours, the carbonic acid gas having to be retained from the lime, as it is necessary in the manufacture of sugar. All the ground floors are solid concrete



PECOS VALLEY BEET SUGAR FACTORY, NEW MEXICO.

The length of the main building is 150 ft, east ell 30 ft, west ell 33 ft, boiler house 43 ft in length. It has a capacity of 250 tons of beets per day. The buildings are so constructed that the capacity can be greatly enlarged when desired. Most of the land is entirely new, bearing its first crop last year. The farmers were also entirely unacquainted with the culture of the beet root, but the results obtained are more than gratifying. Experiments made during the two years previous gave most astonishing results, the crop (all under irrigation) yielding from 12 to 31 tons per acre, with a sugar content of 14 to 21 per cent. This year it is believed that not less than 3000 acres will be grown for this factory.

and all the buildings are lighted with electric lights, which is generated on the premises. There are two sugar store warehouses; one 75x40 feet, the other 125x40 feet, the total capacity of which is 40,000 bags of sugar. The total weight of machinery is upwards of 1000 tons.

So prosperous has Lehi become that in 1896 there was not a single delinquent taxpayer. This is a remarkable fact for any town, but especially for a western community which has more or less "floating" population. But the Lehi people are "stayers" since the sugar industry is established.

NEW MEXICO.

The Pecos Valley Beet Sugar Co established a factory at Eddy, New Mexico, late in 1896, and are planning for a 700-ton plant 75 miles north of that place, to be erected this year. The Eddy plant was late in starting, and from Nov 25 to Jan 1, '97, received 3706 tons of beets and the total supply was about 18,000 tons. Many farmers irrigated too much and others did not cultivate properly, but in spite of these obstacles the first crop averaged about 12 tons per acre on the 1500 acres grown, while some fields, properly worked, made nearly 20 tons per acre, the range in yield running generally from 8 to 16 tons per acre. The sugar content ranged from 14 to 21 per cent and over 80 purity, and the average for the total tonnage will "probably be close to 16 per cent." Enough has been done to indicate that the arid southwest is likely to prove well adapted to the sugar beet. In spite of the unusual winter weather, in spite of a late start in making sugar, and in spite of all the numerous obstacles that beset such an enterprise the first season in a new country, the company report that their "most sanguine expectations are being realized." Making every discount possible for the claims of interested parties, it is evident that a brilliant start has been made for the Pecos Valley sugar industry. Seldom, if ever, has an enterprise of this kind in the United States done as well its first year.

WISCONSIN.

A sugar factory was erected at Menomonee Falls, Waukesha Co, Wis, about fifteen miles northwest of Milwaukee, in 1896. The enterprise was due to the efforts of Mr K. G. Korn, who has patiently worked for years to develop the enterprise. He is the general manager, having entire charge of designing the factory and building and installing the machinery. He gave his time to the work without pay until the factory was in operation and had the machinery built at machine shops in Milwaukee. On account of the disturbance in financial affairs, the factory was not ready for business until January, '97, but it had nearly 18,000 tons of beets in silos waiting to be manufactured into sugar, as illustrated and described on Page 61. The campaign closed late in March, '97, with a satisfactory run up to latest reports. The greatest difficulty Mr Korn found was to get farmers to grow the beets, but after an 18-months' canvass he succeeded in getting a ten years' contract for growing 2500 acres of beets from 350 farmers within a radius of ten miles of the factory. The contract agrees to pay $4 per ton for all beets testing 12 per cent sugar, $5 for those testing 16 per cent, and an annual premium of $50 for the best grown field of beets. An average test from several of the largest crops of '96 show from 12½ to 13½ per cent sugar, and it is believed that

STORING BEETS IN WISCONSIN.—MENOMONEE FALLS FACTORY IN DISTANCE.

These silos are 6 feet wide at bottom; beets are piled in ridges about 2½ feet high, and then covered with 1½ feet of earth shoveled over them from the intervening space. No straw was used; ventilators every 10 feet. In spite of warm weather since the beets were ensiled in October and November, 1896, they came out perfectly in February, losing only 1¼ % of sugar on the average. The beets averaged about 14 % sugar when put in, and 12½ or more when taken out. Nearly 10,000 tons were stored in the silos illustrated, and 8,000 tons by the farmers. The plate is from Bulletin 55, Wisconsin experiment station.

the yield will average 12 to 14 tons per acre; many raised 15 to 18 tons per acre, and one crop made 23 tons of good beets per acre. The factory, illustrated on Page 61, has a capacity of 275 tons of beets per day of 24 hours.

This factory is the outcome of elaborate inquiries conducted by the Wisconsin experiment station that show almost the entire state to be wonderfully adapted to the sugar beet. The beet ripens ordinarily by Sept 15 or 20, and until Nov 10 there is little danger from cold, but after that silos will be necessary if a factory is to run much over 60 days. Hundreds of pounds of beets have been grown all over the state and analyzed at the station, showing total averages of from 12½ to 14½ per cent of sugar, while many samples ran up to 18 per cent and the co-efficient of purity averaged over 80. The Vilmorin gave the richest sugar and the Despez Richest the next. As a result of all this work, there is a deep interest in the sugar question.

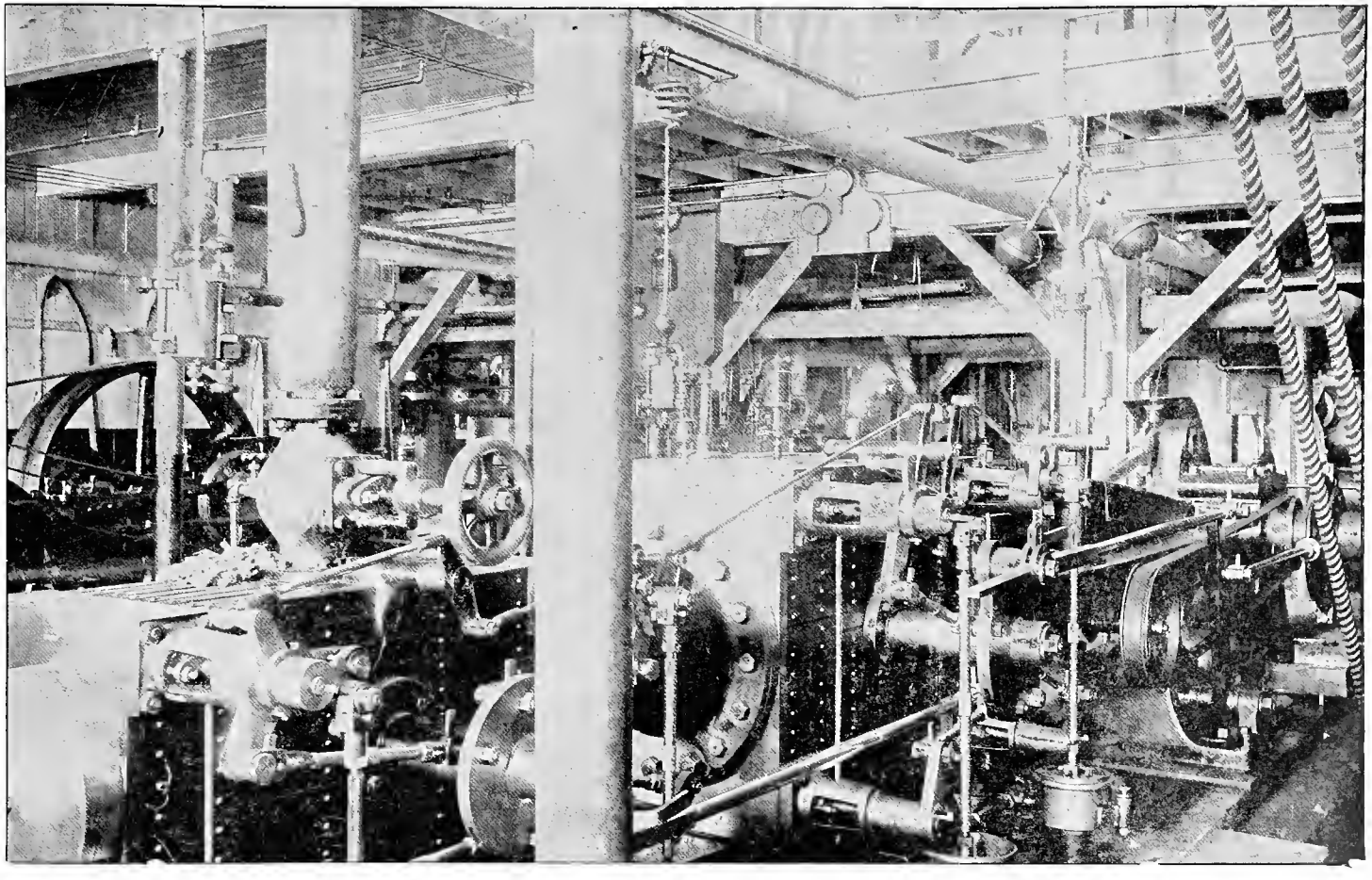
OTHER STATES.

So much for results in states in which beet sugar factories are already in operation. In many other states much work has been done in growing beets to test the adaptability of the soil to this crop. Thousands of analyses have been made by the United States department of agriculture and by several of the state experiment stations. It is evident from all this work during the past ten years that beets can be commercially grown at a profit over most of the vast area indicated in Map No 3, frontispiece—from the Hudson to the Pacific, from the Carolinas to the Lakes. We do not advocate the industry for New England, because the limited areas suitable for beet culture can hardly compete with the wider areas and more fertile soils of the middle and western states.

NEW YORK—We did nothing in the way of testing sugar beets in 1895. In the spring of 1894, we sent out 45 packages of seeds to the various counties of the state. The following table sets forth in brief the average weight of beets, the average yield per acre, the per cent of sugar and the average yield per acre of sugar of three varieties in 1894:

Variety	Average weight in ounces per beet	Average yield in tons per acre	Average % sugar	Average yield of sugar per acre
Mette,	32.76	26.5	10.05	5326.5 lbs 2.66 tons
Vilmorin's Imperial,	34.16	34	6.92	4705 " 2.35 "
D K'wanz,	30.59	24.77	9.38	4246.5 " 2.12 "
Average of all,	32.50	28.42	8.78	4759.4 lbs 2.37 tons

These plots were small, and it is to be supposed that the yield was much larger than could have been secured on large areas and that the beets selected were larger than the average. During the season the beets stopped growing in midsummer, and became nearly ripe. Fall rains started them to growing most vigorously and they put out new leaves, which without doubt greatly diminished the sugar content. The largest yield (D. K'wanz) was 56 tons per acre with 8.5 per cent of sugar. The next largest (Vilmorin's Imp) was 54 tons with 5.05 per cent sugar. Westchester county reported a yield of 12 tons and 12.7 per cent sugar of the variety Vilmorin's Improved, and Seneca county 6 tons with 5.7 per cent sugar. The yields and per cent of sugar were extremely variable. In 1893, eight plots of Dippe's Kleinwanzlebener, in various counties, gave an average of 21 tons with 12.86 per cent sugar. Twelve



A GLIMPSE INTO THE ENGINE ROOM, UTAH FACTORY.

plots of Knauer's Imperial, variously distributed, gave an average of 26 tons with 12.5 per cent sugar. Seven plots of Vilmorin's Richest gave 14 tons with 13.2 per cent sugar. Clay soils gave 13 tons with 12.5 per cent of sugar (all varieties); clay loam 22 tons with 13.1 per cent sugar, and sandy loam and gravel 28 tons with 12.6 per cent sugar. We now have two imported varieties growing which will be tested later.—[Prof I. P. Roberts, director of Cornell agricultural experiment station and professor of agriculture in Cornell university.

MIDDLE STATES—Comparatively little has been done in Pennsylvania. In New Jersey, Maryland and Delaware, no proper tests in beet culture have been made recently, but good beets were grown in the 70's, and there is no reason why the crop should not thrive on certain soils properly fertilized. Recent Maryland tests have not given promising results.

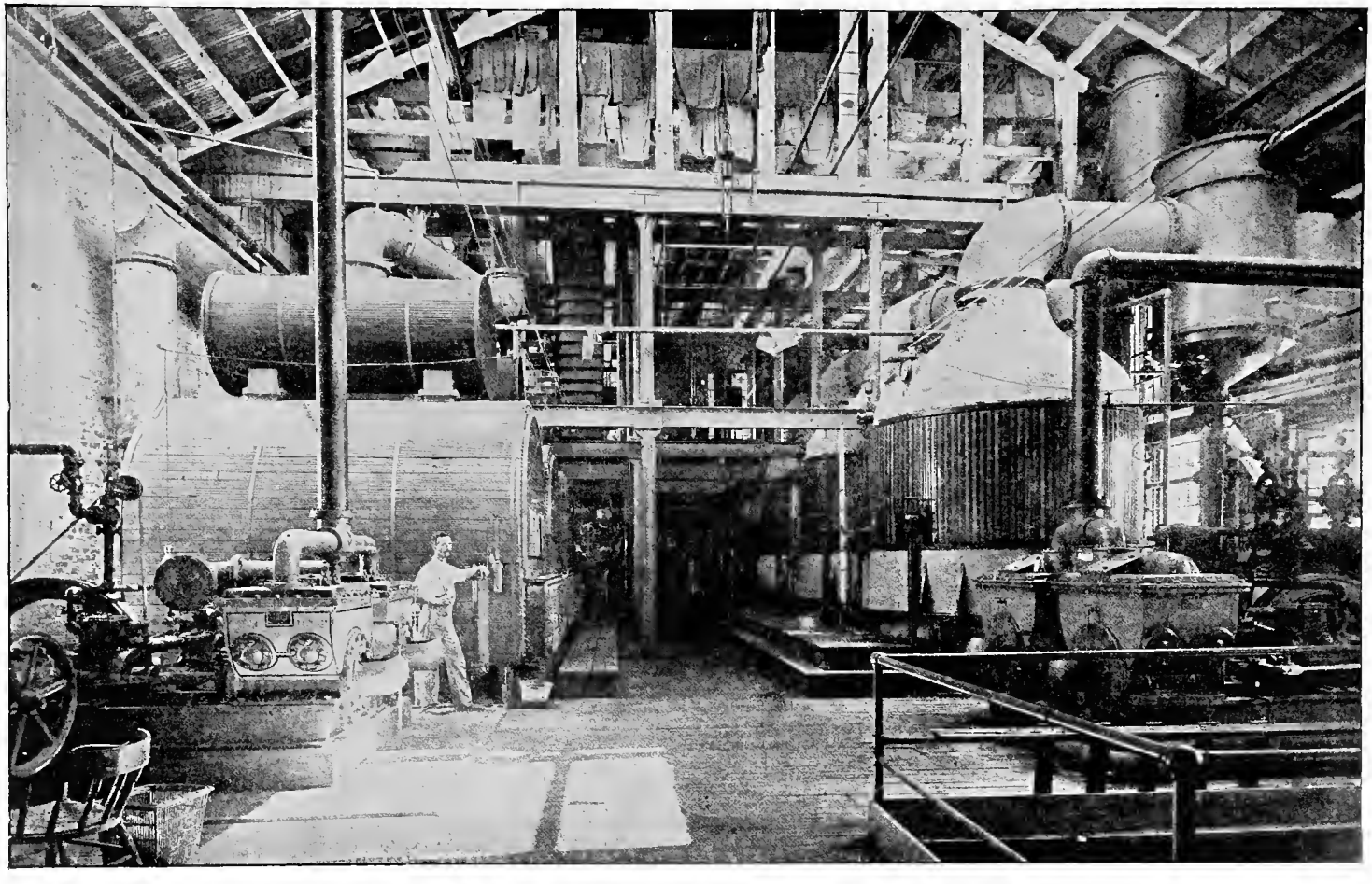
OHIO—The experiment station has done little in this line, but private tests are encouraging, and thousands will be made in 1897.

MISSOURI—In 1890, on upland limestone clay loam of average fertility in Boone county, yield per acre highest 19 tons, lowest 12, average 15; sugar, highest 18 per cent, lowest 10, average 14. In 1891, same farm, yield 8 to 12 tons, average 10; sugar 7 to 14 per cent, average 11½. In '92, tests were made in five northwestern counties, northeast nine counties, southwest five, southeast one county, representing seven different varieties and 55 samples: Per cent of sugar in beets, highest 19, lowest 4.6, average 9.8; purity, 47.5 to 79.3 per cent, averaging 67.3. These varieties at the station in Boone county that year yielded 9 to 12 tons per acre, mean 8.8 tons; per cent of sugar 7 to 13, average 11; purity 65 to 75, average 70. Director Waters says: "Results thus far not encouraging, soil much too compact and hard; Missouri lies south of best sugar belt, mean summer temperature 6 per cent higher than in counties producing this crop most successfully." We suggest much more work for several seasons before throwing Missouri out of the sugar belt.

OKLAHOMA—Little work done. Director Morrow "believes climatic conditions give little prospect of success." But if beets do wonders in Pecos valley, N M, they ought to be tested thoroughly in Oklahoma. This also applies to Indian Territory.

KANSAS—Many plots of sugar beets grown at state experiment stations at Manhattan and other parts of state, '90-2. First year not conclusive; 360 tests in 56 counties were unsatisfactory in '91, owing to climatic conditions. For '92, the station and 85 farmers over the state raised beets, but the season was again unfavorable and the results "cannot be regarded as lending great encouragement to the hope of the successful establishment of the beet-sugar industry in this state. There are, however, a considerable number of samples showing a high percentage of sugar." More work is needed and evidently irrigation or other insurance against drouth is required.

SOUTH DAKOTA—Experiments were conducted in every county, 1889-93, results in four bulletins, of which Nos 27 and 34 can still be supplied. Yield 10 to over 40 tons of beets per acre on acre plots running from 15 to 20 tons as a fair average; sugar content 9 to 20 per cent, very few samples below 12 mostly 13 to 16 per cent, three-quarters of all samples showing 16 per cent sugar or more. Chemist J. H. Shepard



DOUBLE SET QUADRUPLE EFFECT EVAPORATORS, CHINO.

concludes: "The state is well adapted to sugar-beet culture, tonnage very high, purity co-efficient quite satisfactory, averaging about 85."

NORTH DAKOTA—E. F. Ladd, chemist, reports analyses of beets grown in '91 from 129 farms in all parts of state, yielding estimated average of 13 tons per acre, containing 7 to 18 per cent sugar, average 11.43, purity 46 to 98. In '92, Prof Ladd believed other crops would be more profitable in most of the states; his letter in the fall of '96 expresses no opinion. But further private tests and experiments in Utah, Nebraska and Wisconsin, prove beyond question that the beet sugar industry can be made a great success in most parts of North Dakota.

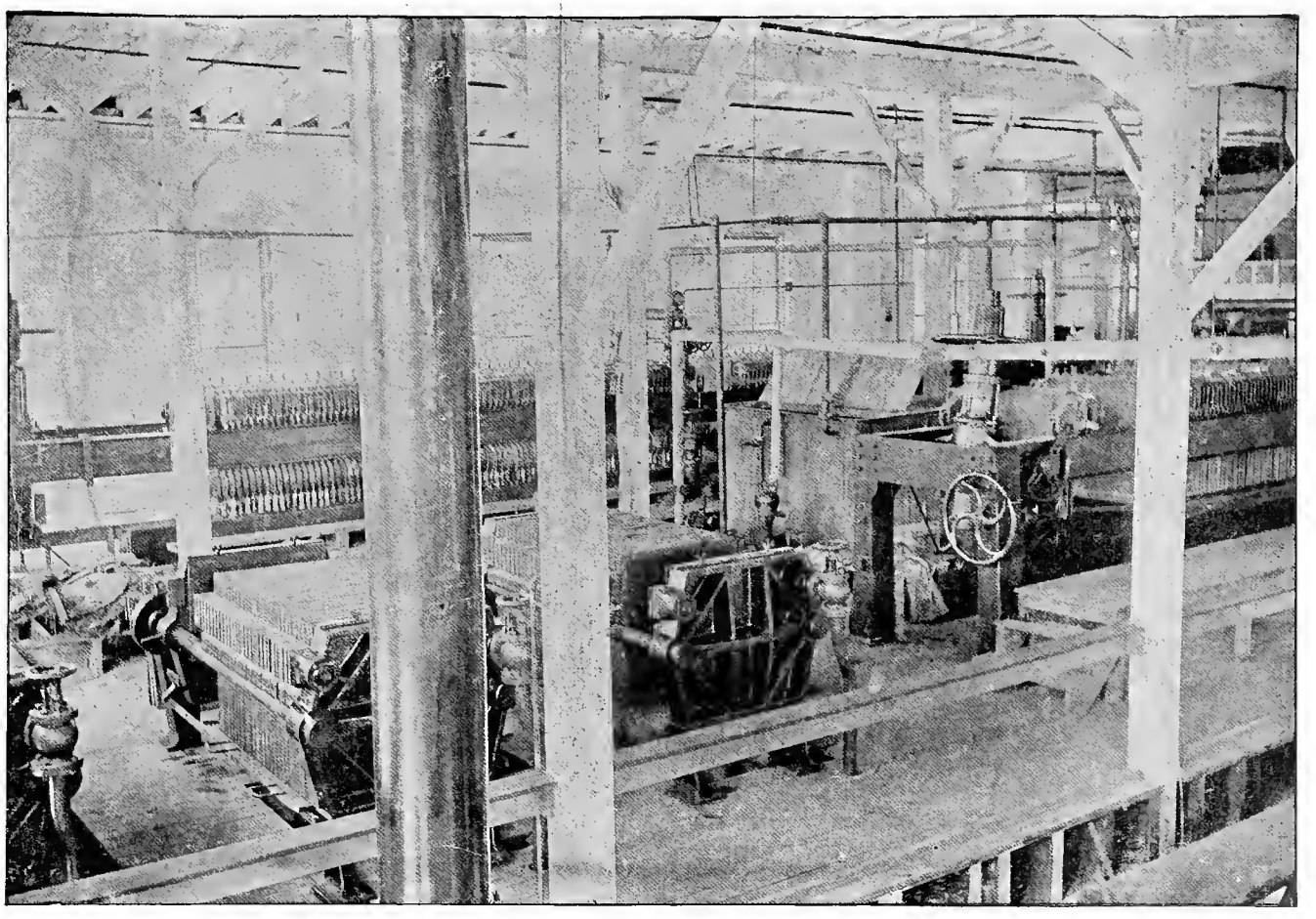
MICHIGAN—Tests were made all over the state in 1891. Season was unfavorable, drouth serious, results conflicting. In western counties 28 farmers reported an average of 15 tons of beets per acre containing over 14 per cent sugar; southeast, 21 reports averaged 16½ tons and 13½ per cent sugar; central, 40 reports averaged 13 tons of 14½ per cent sugar; northeastern, 49 reports averaged 15 tons and 13½ per cent sugar. This makes a promising outlook for both farmer and manufacturer, especially in southern Michigan. See Bulletin 382, Experiment Station, Agricultural College P O.

INDIANA—About 300 analyses reported (by H. A. Huston, chemist) of beets grown in 150 different localities all over the state in 1889-94, show highest yields of 12 to 42 tons per acre, lowest 3 to 13 tons; sugar, in juice, highest 14 to 18 per cent, lowest 5 to 10; purity, highest 87 to 90, lowest 58 to 70. Small plot tests prior to '94; that year, ten fields of ½ to 1 acre averaged 19 tons per acre, and half of these fields gave beets of quality sufficient for sugar manufacture. Chemist Huston adds: "Beets of satisfactory quality can be grown in all parts of Indiana. With one exception, all correspondents who have raised beets in large plots believe that at $4 per ton this crop would pay a profit." H. Cordez, who has been working for two years to establish a factory near Evansville, southern Indiana, obtained 15½ and 16 per cent sugar of 85 to 90 purity in small plot tests in '96.

ILLINOIS—Because farmers failed to raise enough beets to run the factory at Freeport many years ago, and because on some soils the crop did not seem to thrive, the impression has gone out that this state could not grow beets. The experiment station has done very little to ascertain the truth. Until the matter has been as widely tested as in Minnesota or Wisconsin, correct judgment cannot be formed. Until such tests prove to the contrary, we shall believe Illinois has thousands of acres that can be readily adapted to this crop.

MINNESOTA (Prof Henry Snyder)—It has been the aim of the state experiment station to test, in as thorough and impartial a way as possible, the adaptability of Minnesota's soil and climate to the growing of sugar beets. The work has been carried on for eight years, during which time 1079 samples of sugar beets have been analyzed, showing of sugar 10 to 20 per cent, an average of 14 per cent; purity 70 to 94, an average of 80½. The beets have been grown in a large number of counties throughout the state. It is believed that the experiment station has demonstrated that sugar beets, with a high per cent of sugar and co-efficient of purity, can be raised in Minnesota, at a cost of $2 to $3 per ton. The average yield per acre was 15 tons.

IOWA—For the purpose of ascertaining by repeated experimentation how well Iowa is adapted to growing sugar beets, we began in 1891 and have grown and tested



FILTER PRESSES, UTAH BEET SUGAR CO., LEHI.

sugar beets every year since that time. We have probably three or four acres growing on the station grounds at present. Seed has been sent to a majority of the counties of the state, so as to give us wide and comprehensive reports regarding the ability of our state in its several counties to grow beets with a sufficient percentage of sugar to make the industry profitable.

We also, in 1891, conducted an experiment on the college grounds with a piece of land over an acre in extent, having different kinds of soil and treated different ways, so as to ascertain what soil is best and what method of cultivation is advisable. From the whole field, we got an average of 20 tons to the acre with 14.14 per cent sugar in the beets, and 76 per cent average purity of juice. We grew this field of beets under twelve different conditions. We used different kinds of fertilizers on three pieces, but got no evident benefit; we got our highest average of sugar from the piece of ground from which woods had been cleared off, 15.17 per cent of sugar with 82.3 purity of juice. We let one part of the field on low, rich loam grow the beets as large as we could possibly grow them by thinning them out; the average purity of juice went down to 72.8 and the sugar in the beet was 11.52. Only three of the twelve conditions gave us sugar in the beet under 13 per cent. We got the greatest tonnage from early planting; subsoiling gave us the best shaped beets. The percentage of sugar was affected by rains in October causing a second growth. Our highest analyses came from beets averaging 13 ounces trimmed, and yielding 12 and 13 tons per acre; our highest yield of sugar per acre came from beets averaging 21 ounces trimmed, and yielding over 28 tons to the acre. Clay soil gave us the highest per cent of sugar, comparatively higher purity, and lowest tonnage per acre. We had no distinctively sandy soil.

Reports from different counties in the state show a wide range of sugar per cent and purity co-efficient. The highest we have received comes from Muscatine county; over a hundred farmers reported from that county in 1891. About 10 per cent reported a sugar per cent under 12, while half of the number report the sugar in the beet over 15 per cent, and some run as high as 19 per cent.

I have no doubt that a large area within the state will grow sugar beets profitably. The purity of the juice is not as high in our state in all parts as it is in others, but the yield per acre has much to do with the profitableness of the crop, and from reports of the growth of beets west of us, I am satisfied that our tonnage is much heavier than is common in drier states. Iowa soil is so well supplied with plant food of all kinds, organic and mineral, that no fertilization is required. We sent to Louisiana and got the most approved sugar-cane-growing fertilizers, but were unable to see any improvement whatever from their application. Our soil has abundant lime, potash, phosphoric acid and nitrogenous compounds, so that apparently only capital and skill are necessary to make all of the sugar in Iowa that the United States may require.—[James Wilson, (Director Iowa experiment station; Professor of Agriculture Iowa Agricultural college; Secretary of Agriculture for the United States—1897-1901).

IN THE WEST.

There is no longer a shadow of a doubt as to the adaptability of vast areas to the sugar beet, although it is true that more extended experiments are necessary in some sections to further demonstrate the quantity and quality that can be raised. Espe-

A FIELD OF 210 ACRES OF SUGAR BEETS IN THE PECOS VALLEY,

On the celebrated Vineyard Farm, Eddy, New Mexico

cially is this true in Montana, where practically nothing was done in this line until the past year. In Wyoming, on the other hand, many tests were made 1891-5, showing average yields of from 8 to 14 tons per acre, an average sugar content of from 16 to 17 per cent with from 78 to 83 purity. Summarizing all this work done by the state experiment station at Laramie, Prof Buffum concludes that "the yield averages sufficient to make it a profitable crop, while the beets are of better quality than in many states where factories are successfully operated."

In Colorado, more than 50 localities have grown beets and the conditions have proven favorable everywhere under 7000 ft altitude, though best under 6000 ft, when the ground and crop are properly handled. Co-efficient of purity is good. The yield runs from 10 to 15 per cent of sucrose, averaging fully 13 per cent, and under proper conditions much more than that. Results in New Mexico, Arizona, Utah and California have already been enumerated.

In Idaho, the yield runs from 10 to 26 tons per acre with a large sugar content of high purity. In Washington, very fortunately, a great number of experiments have been conducted in most parts of the state under the auspices of the state experiment station at Pullman. Over 1700 analyses have been made, showing an average of more than 15 per cent sugar of nearly 84 purity. The beets from almost every county closely approximate this standard. It is a remarkable showing and demonstrates beyond a peradventure that the state of Washington is singularly adapted to the industry. The average yield per acre is not reported, but Prof Fulmer says: "It is probable that an average of 20 tons per acre would be a conservative estimate." Allowing for the extraordinary richness of Washington soil, it is probable that this is rather high. In Oregon, tests were conducted for three years 1891-3, and again last year, showing that beets raised under all sorts of conditions varied from 8 to 22½ per cent sugar in the juice of above 80 purity. Prof G. W. Shaw's analysis of beets grown by an expert in Washington county the past year averaged 16½ to nearly 18 per cent sugar of 88 to 91 purity, and even after the second rains in the fall these beets averaged over 12 and 80. Prof Shaw believes that even west of the Cascade mountains, the earlier crops of beets would be harvested before the fall rains start a second growth, and that even in that region as well as east of it, the state is wonderfully adapted to the sugar beet.

IN THE SOUTH.

VIRGINIA—Mr O. K. Lapam, who operated a small factory at Staunton, Va, for two or three seasons, until it was burned, is enthusiastic over the possibilities of the industry in this section. The beets averaged 14 to 14½ per cent of sugar and yielded an average of from 12 to 13 tons per acre, at a cost of from $10 to $40 per acre including delivery of beets to factory and fertilizers as well as all other expenses. He estimates the average cost at $25 to $30 per acre in the south when beets are grown within five miles of the factory. At $4 per ton and an average of 12½ tons per acre, the income would be $50 per acre. To this should be added six tons of pulp, worth to the farmer $2 per ton or $12 per acre, while the improvement of his land by deep tillage and thorough destruction of weeds is at least $5 more. The crop which follows beets will yield 50 per

cent more than on the same land not having been previously used for beets. Mr Lapham "knows of no industry more needed in the south than this to improve the land, while insuring a sure and profitable return to the farmer, and incidentally benefiting all classes connected with it."

In North Carolina, sugar beets have not been tested since '87-8, when the results were discouraging. Director H. B. Battle of the experiment station at Raleigh says: "Should there be a demand for the product for manufacturing sugar, the cultivation could be rapidly and successfully developed."

In Kentucky, Director M. A. Scovell of the experiment station at Lexington is not hopeful of results, owing to the comparatively low sugar content, but H. Cordez cultivated three kinds of sugar beets on an alluvial soil in Green River valley, western Kentucky, in '96, which showed 16 to 17½ per cent sugar of more than 80 degrees purity, and he is very confident that the crop will thrive over much of this state.

In Tennessee, Secretary Vanderford of the state experiment station at Knoxville, writes: "I am satisfied that there are areas of considerable extent in all divisions of the state, and particularly in west Tennessee, where sugar beets of more than average sucrose content and of high purity can be grown at an average cost of $3 per ton or less. Under adverse conditions, upon an unsuitable soil on our station farm, we have demonstrated that sugar beets can be made profitable in Tennessee."

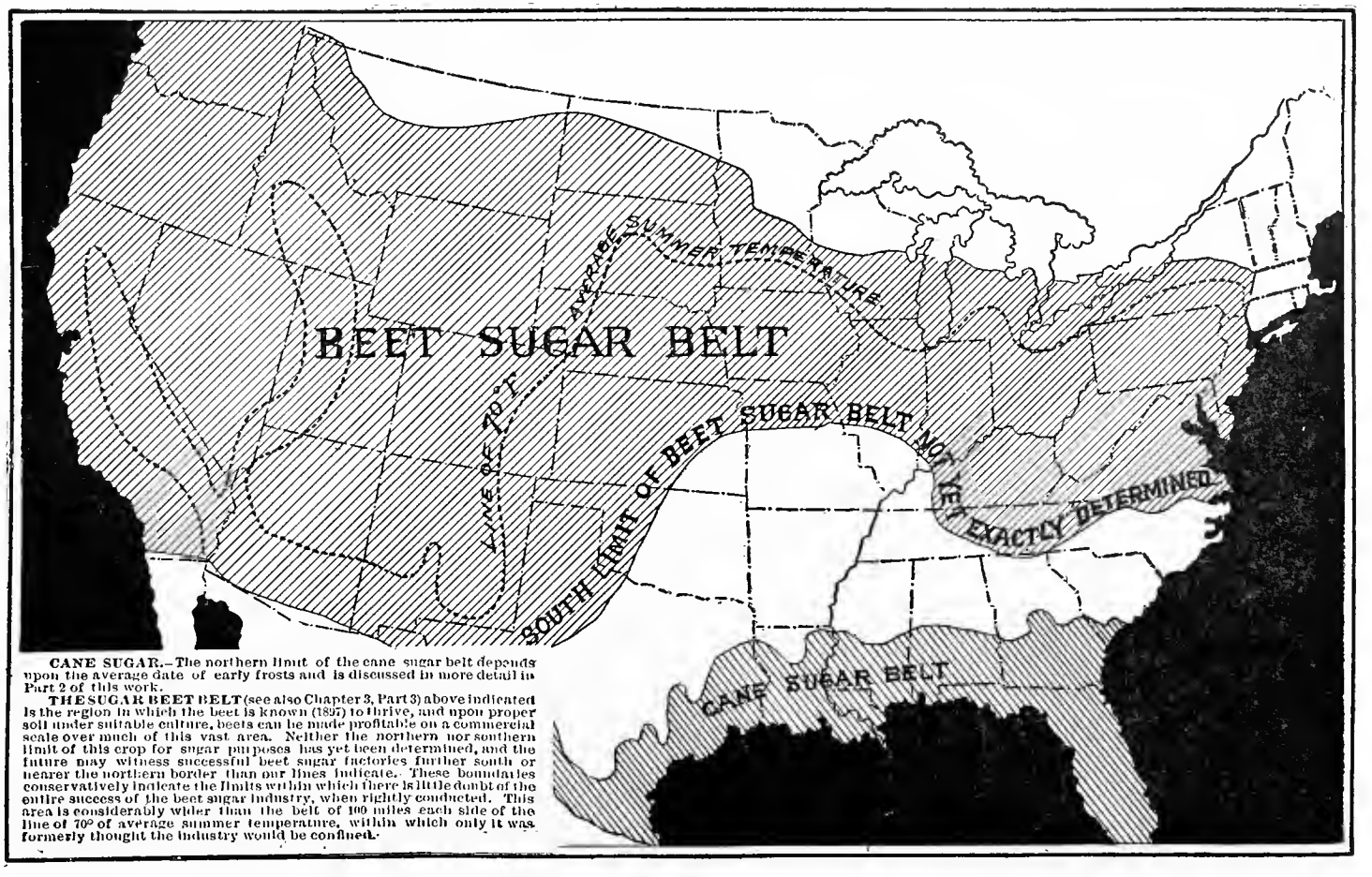
The Arkansas station reports having grown sugar beets in three parts of the state but the yield and sugar content were varying and unsatisfactory. "The temperature is hardly suitable in this state, except perhaps in the northwestern part," say Director Bennett, but we would suggest more exhaustive inquiry before accepting the accuracy of this opinion.

Prof W. C. Stubbs writes: "It is doubtful whether the sugar beet can be grown south of the Ohio river with profit. Our experiments in Louisiana have clearly shown that no reliance can be placed on the sugar beet crop in this state. This is due to the fact that frequently beets are planted here in the fall and are grown throughout the entire winter. It is with us more of a fall and winter crop than a summer crop, and since sunshine is needed to elaborate the sugar, it is rarely that we find beets here rich in saccharine matter."

No tests are on record as to the adaptability of the soils and climates of northern Mississippi, Alabama, Georgia and South Carolina to the sugar beet, although it is probable that the crop will be widely tested all through these regions.

In Texas rich beets are raised in the temperate climate of the semi-arid region under irrigation, but in the warmer and more humid part cane does better, as beets here are poor in sugar.

Certain practical men, who have had large experience in sugar-beet culture and manufacture in this country and who are also acquainted with European conditions, are strong in the belief that the middle south, meaning especially Virginia, West Virginia, Kentucky and Tennessee, will yet prove to be a fine location for the beet sugar industry, because of the long season, abundance of sunshine, nearness to market and other conditions.



CANE SUGAR.—The northern limit of the cane sugar belt depends upon the average date of early frosts and is discussed in more detail in Part 2 of this work.

THE SUGAR BEET BELT (see also Chapter 3, Part 3) above indicated is the region in which the beet is known (1897) to thrive, and upon proper soil under suitable culture, beets can be made profitable on a commercial scale over much of this vast area. Neither the northern nor southern limit of this crop for sugar purposes has yet been determined, and the future may witness successful beet sugar factories further south or nearer the northern border than our lines indicate. These boundaries conservatively indicate the limits within which there is little doubt of the entire success of the beet sugar industry, when rightly conducted. This area is considerably wider than the belt of 100 miles each side of the line of 70° of average summer temperature, within which only it was formerly thought the industry would be confined.

BEET SUGAR AND CANE SUGAR AREAS IN THE UNITED STATES.

CHAPTER III.

CULTURE OF THE SUGAR BEET.

CLIMATIC CONDITIONS.

BEETS THRIVE BEST in a temperate climate, which in the United States covers a vast area. While the plant develops under a great variety of weather conditions, more recent experience seems to confirm in a measure the previously accepted theory that the sugar beet as a rule does best in regions where the average temperature for the months of June, July and August is about 70 degrees F. This isothermal line has been carefully determined by the United States department of agriculture and is indicated on map No 3. (See frontispiece.) Dr Wiley in 1890 regarded the sugar beet belt as extending about 100 miles on each side of this line. Experience since shows that the area adapted to this crop is by no means limited to this belt and that it is far larger than has been supposed. The map referred to indicates in a general way the area in which both soils and climates can be found peculiarly adapted to the sugar beet.

Sunshine is required to make sugar. Hence, the number of clear and sunshiny days that can usually be depended upon in any section is an important consideration, which has not been sufficiently emphasized in much of the literature heretofore published. This explains the advantage of many parts of the so-called arid west for this industry, especially California and the Southwest.

Another important climatic consideration is favorable weather during the ripening and harvesting period. Clear sunshine, absence of fogs and moisture, are important at this period. We have seen how in 1895 a fine crop of sugar beets in Nebraska was almost ruined by a warm, wet spell early in the harvesting time. While this is unusual in many of the eastern and central states, it is liable to occur in most of the country east of the 100th meridian. Such weather starts a new growth of the beets that consumes the sugar or changes it to starch, and it requires several days of sharp sunshine and warmth, without too much humidity, to restore the sugar content.

The beet must also have sufficient moisture at the right time to produce the best results. This moisture must come either from the rainfall, from irrigation or "the soil must be of that peculiar quality that will allow subterranean moisture to reach the rootlets of the plant," which is the case in parts of California and some other states. While proper cultivation of a subsoil soil will enable the beet to thrive with

more or less water, Wiley maintains that an average summer precipitation of 2 to 4 inches per month is desirable. Nebraska experience shows that a good crop is assured, provided other things are done properly, if May and June are warm and not too wet, July and August wet and not too hot, September and October warm and dry.

The longer the season the more favorable to this industry. In California, planting begins as early as January on the higher and dryer soils and continues until June on the lower and more moist lands, thus maturing the crop continually from about the first of August to almost the new year. In the vicinity of Watsonville, planting of the '97 crop began as early as Jan 15, while the last of the '96 crop was hardly out of the ground on the last day of the year. In other parts of the country, the planting has to be done in a short time, usually during May, because the ground is too cold and later the season will be so short as to prevent maturity before frost.

Another advantage in the mild climate is the longer period of harvesting. As just noted in California, beets may be harvested during the last five months of the year, whereas in most other sections, the digging must be completed before hard frosts. It has been assumed that beets would keep longer in the mild winter of California (where frost is almost unknown) than in the severe winters of the north and east. It has been customary to keep the beets in cold climates in silos but Utah experience during the winter of '96-7 indicates that such protection against cold may not be as necessary as has been supposed. This point is further discussed under the head of storing beets. Certain it is that a climate which allows a factory to run from 100 to 150 days in ordinary seasons is far more advantageous than sections where the mill can not have good beets to run on more than 80 or 100 days.

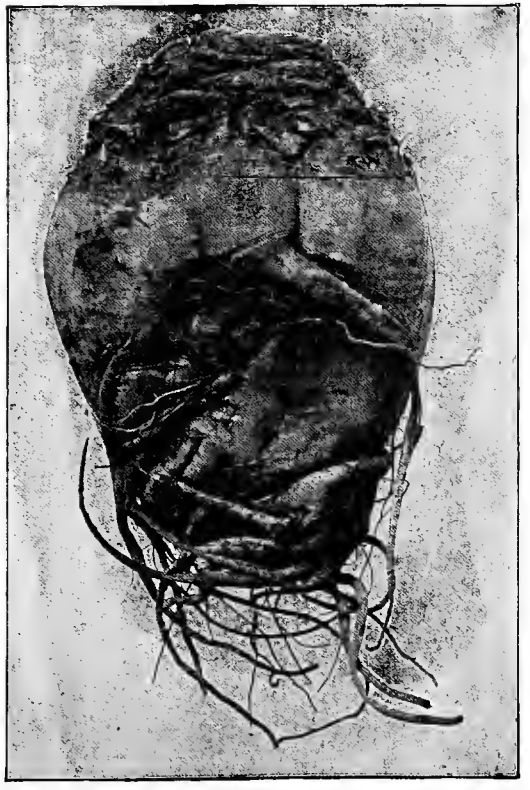
VARIETIES OF BEETS.

"All kinds of sugar beets are botanically identical with the common garden beet, *Beta vulgaris*. The differences in varieties have arisen by reason of special selection and culture producing a pure strain of some valuable peculiarity in the beet. These accidental valuable qualities by careful selection have become fixed and are associated with certain external properties which have thus come to be regarded as distinguishing characteristics.

"The shape and size of the beet, its color, the character of its foliage, whether erect or spreading, etc, are the most frequent marks of distinction. The beets are also frequently designated by the names of those who have developed them, or by the name of the town or locality in Europe in which they have been grown, or by their color.

"Among the more frequently occurring varieties grown in Europe may be mentioned the Vilmorin Improved, Klein Wanzlebener, Improved Klein Wanzlebener, White Excelsior, White Imperial, Simon Le Grande, Florimond and Bulteau Desprez Richest, Brabrant Sugar Beet, Rose Imperial, White Silesian, etc,

"The two varieties which have been most widely grown in this country are the Vilmorin Improved and the Klein Wanzlebener. The certainty that the seed has been grown according to the most scientific methods is of greater importance to the beet grower than the variety. The beet has reached such a high state of perfection



A POORLY SHAPED BEET.

Due to shallow plowing and hard subsoil. Cornell, 143.

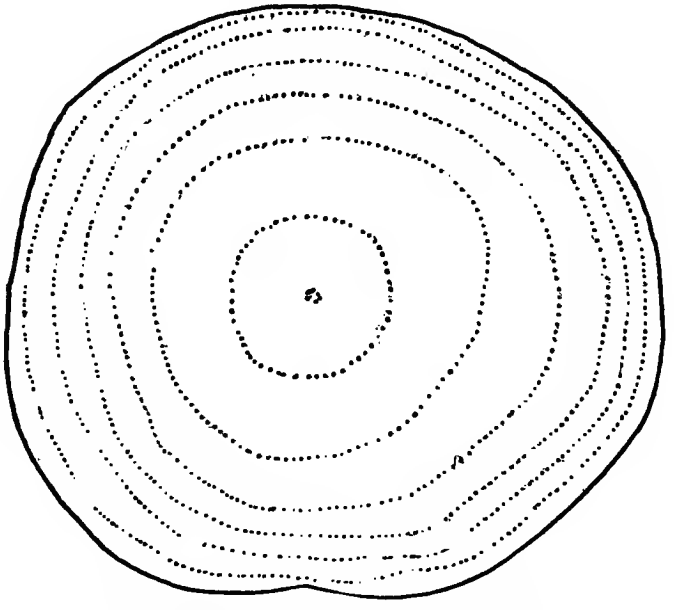
AN IDEAL SUGAR BEET.

Grown in good soil with a porous subsoil, Western New York. Cornell Bulletin 143.

as to make the least degree of laxity in its treatment exceedingly dangerous to its qualities."

The two kinds named are preferred in California, Nebraska prefers Dippe la plus Riche, Dippe Klein Wanzlebener, Original Klein Wanzlebener, and Vilmorin's Improved White. The two latter varieties are mainly grown in Utah.

No variety of sugar beet is suited to all conditions. Different soils and treatment make peculiar demands upon the variety. Experience with varieties in other parts of this or foreign countries is not a safe guide. The only practical way is to find out by actual experiment on each farm which variety does the best in yield and quality under its conditions. The seed must be good—of strong germinating power. "Cheap"

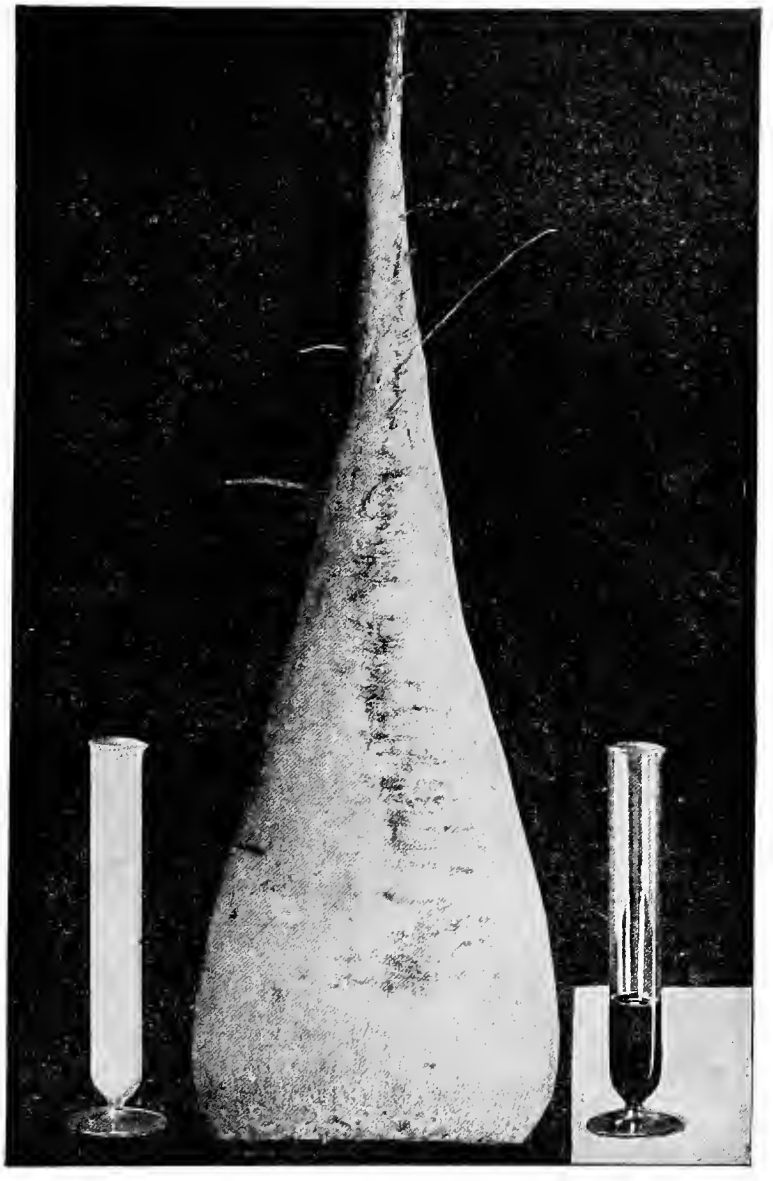


CROSS-SECTION OF BEET

Illustrated on page 32. This cross-section is life size at the point of largest diameter. The dotted lines show the concentric rings of growth.

seed is in the end the most costly. This country is producing some seed now, and in a few years will doubtless grow all its beet seed, as discussed later in this chapter.

SIZE OF BEET—It is generally considered that large beets, weighing more than 3 lbs, are usually of poor quality. This depends entirely upon the soil upon which they are grown, and upon the variety of seed. As a general rule, however, it can be said that the large beets are lower in quality than small ones. The size most desired is from 1¼ to 2 lbs in weight. Where beets are too large or too poor in quality to be worked at the factory, they can be utilized for stock feed. For this purpose the beets are considered in France worth 75 per cent as much as the price that is paid for them for sugar making. In France, almost twice as many beets are grown for



SUGAR BEET MOLASSES

Showing relative quantity of granulated sugar and of molasses obtained from a beet. About one-half real size. Determination by G. W. Shaw, Oregon Experiment Station. Engraved from a photograph used to illustrate his bulletin, No. 53, April, 1898.

stock food as for sugar. In that country the leaves are sold to adulterate tobacco and it is said that in some cases fully enough to pay for the expenses of cultivation.

SOILS FOR THE SUGAR BEET.

This plant thrives on a wide variety of soils. In Virginia, a warm clay or slaty soil, mixed with some sand and having a depth of 15 inches or more, gave the best results. In other states where the industry is not yet established, experiment shows that the plant thrives on nearly all kinds of lands. But never select poor land—use the best soils available. It seems to do best in these regions on what farmers ordinarily call good potato or corn land. The soil must be well drained, for while the beet requires abundant moisture during the growing period, it does not thrive with "wet feet." It therefore does much better in some soils than in others. The soil must possess good depth, for the beet is a deep-rooting plant, going down 12 to 18 inches.

In Nebraska, the best soil to produce a large tonnage is the so-called bottom land. Hilly land produces generally a better quality, but does not come up as well in quantity. The more lime the soil contains the richer the beets would be. Under no circumstances should seed be planted in soil which is sandy enough to blow. In Utah, and also in the Pecos valley, where one has plenty of water for irrigation, a nice sandy loam is preferred, but if the water supply is scant a clayey soil is better.

In California, the rich, strong, sandy loams that produce heavy crops of wheat and barley yield 15 to 25 tons of rich beets per acre under proper rotation, but lower lands, when well drained of wet or that enjoy natural sub-irrigation from the lower stores of water, are often still better. It has been found at Chino that even when the lower or more moist lands contain as much as 12,000 lbs of alkali salts per acre to the depth of three feet, the beet does well in yield and quality, provided the amount of common salt in the soil does not exceed 0.04 per cent or 1500 lbs per acre to the depth of three feet. But it is wisest to verify on a small scale the adaptability of doubtful land before planting a large area of it.

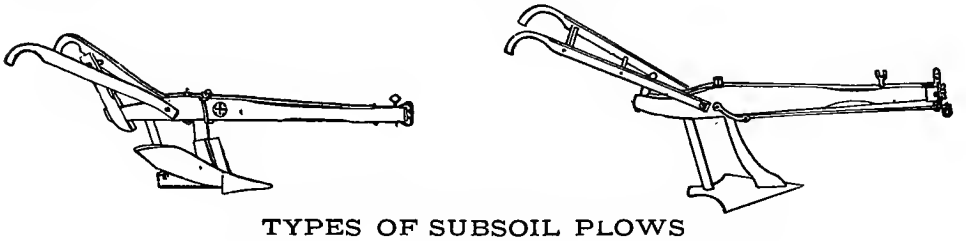
New land, by which we understand land that has only been broken one or two years, should never be chosen for beets, as it produces a crop inferior in yield and quality. In Utah, the best results in sugar and purity are obtained from land that has been in small grain and the best tonnage is obtained from land that has previously had potatoes. Alfalfa land is good for beets, provided two crops of small grain are first grown upon it to get rid of the roots. For preparing new land for beets, nothing is better than to first plant alfalfa or field peas, the latter to be plowed under when in flower. Sage brush or mesquite land is excellent, provided it is thoroughly subdued by preparatory crops, and can be irrigated.

It is also important that the soil be such that the beets can be easily extracted from the ground by a beet puller or plow without breaking the root and without having a lot of soil adhere to it. In this particular, the sandy loam is ideal. To dig the root from a clay or adobe soil is hard work; in such soils the beet tip often breaks off when ripe, and much soil adheres to the beets, thus adding to the freight and to the "tare."

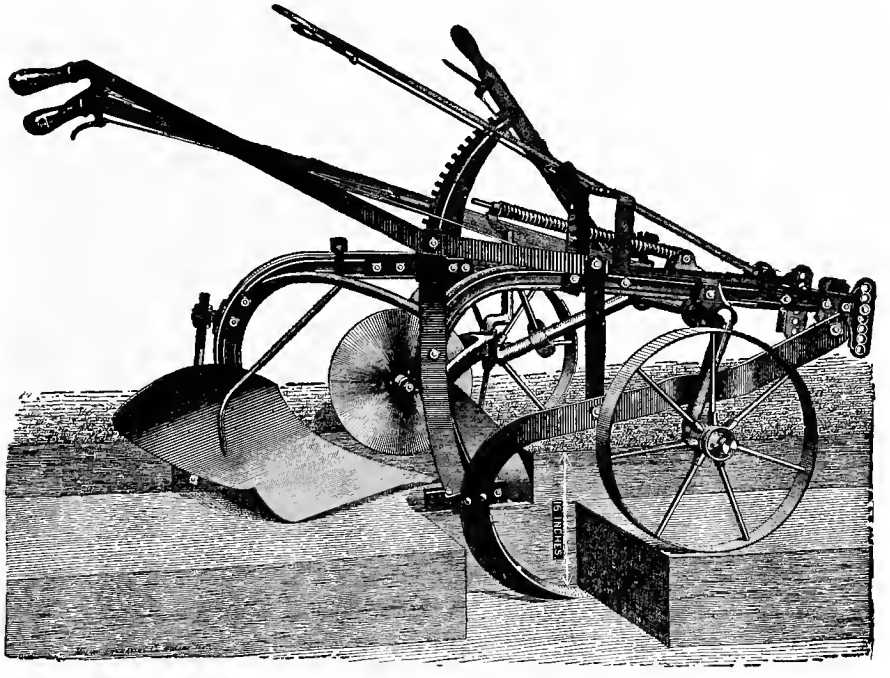
ROTATION OF CROPS.

This is highly important. Beets may do well year after year on the same land, especially if properly manured, but the constant draft upon the soil for the same pro-

portions and kinds of food which this plan involves, must soon impair results. Three crops in succession in Nebraska's rich soil showed marked deterioration in quality. Constant cropping with beets also tends to perpetuate or multiply any pests (insect or fungus) of this plant. It is true that beets have been grown continuously on the same land in California for a dozen years, without apparent injury to yield or qual-



TYPES OF SUBSOIL PLOWS
To follow in the furrow after the first plowing by ordinary plows.



GANG PLOW WITH SUBSOILING ATTACHMENT.

ity, but this does not gainsay the axiom above laid down. Thus far, best tonnage and quality have been secured in California from beets grown on the land every third year, and in Nebraska every fourth year.

New land should be subdued, as stated on Page 78, before being grown to beets. This crop should always follow corn or small grain, because these being harvested early, the land is free for the fall plowing that is absolutely essential to best results with the beet. In Nebraska corn does not seem to do well after beets, neither

should potatoes or other gross potash-feeders immediately precede or follow beets. The best rotation in Nebraska is (1) beets, (2) wheat or oats, (3) corn, (4) wheat or oats or barley, (5) beets. If beets are wanted every third year, the Nebraska rotation is (1) beets, (2) small grain, (3) corn, (4) beets. Utah experience with rotations is limited.

In northern California, beets follow barley most admirably, wheat being the next crop—(1) beets, (2) wheat, (3) barley, (4) beets. Much is yet to be learned about the best rotations under American conditions, but one including one or two crops of clover or alfalfa will usually be found excellent. Instead of giving small grains the second year, a few Nebraska farmers prefer to allow the land to remain fallow, plowing it five or six times to prevent a growth of weeds, then cultivating only in spring before seeding.

FEEDING THE PLANT.

The sugar beet has thus far been mainly grown in America for commercial purposes on comparatively virgin soils at the west without fertilization. In Europe, on the other hand, the liberal use of fertilizers is essential. It is already being found that even our virgin soils will deteriorate if there is not put back upon the land the plant food taken from it by the crop. While the beet takes comparatively large quantities of plant food from the soil, much of this can be returned to the land if the pulp and tops are fed to stock and the solid and liquid excrement applied to the soil. The lime cake and the bone black from the sugar factory should also be used.

AVERAGE QUANTITIES OF PLANT FOOD REMOVED IN 1000 POUNDS EACH OF BEET ROOTS AND BEET LEAVES.

Constituents	Roots lbs	Leaves lbs	Total lbs
Potash,	3.3	6.5	9.8
Phosphoric acid,	0.8	1.3	2.1
Magnesia,	0.5	3.0	3.5
Total ash*,	7.1	18.1	25.2
Nitrogen,	1.6	3.9	4.5

*The ash includes a large proportion of lime.

It will be seen that the leaves contain more than twice as much of the principal elements as do the roots. Hence, the wisdom of leaving them on the field, if not fed to stock. Magnesia and lime are supplied to the soil at low cost in the form of lime cake. The plant requires much lime, and if it is not sufficiently present in the soil its absence must be made good. The plant is a most liberal feeder of potash and nitrogen, its demands for phosphoric acid being comparatively limited; hence, the wisdom of applying fertilizers containing an excess of potash and low in phosphoric acid. We would especially emphasize the importance of potash, for even if the pulp is fed to stock and their manure applied to the land, more or less potash is lost in process by leaching or in the molasses, etc, as well as by failure to utilize all the liquid manure. Potash and phosphoric acid can be used very freely on beet fields and seem to do better together than when applied separately. This is not so with nitrogenous manures or ammoniated substances, which tend to produce a quick and heavy growth of the beet and thus diminish its sugar content. As a general rule, it will be found that in the older and more exhausted soils, the generous use of fertilizers or manures is advisable, as the land must be made rich. On the newer soils at the west, just what

A WISCONSIN PIONEER BEET FIELD.

View of 18 acres of sugar beets grown by Francis Walterlin, Menomonee Falls, Waukesha Co., Wis., season 1896. (From Bulletin 55, Wis. Experiment Station

fertilization is best is yet a subject of experiment and much is also to be learned about fertilizers on old land.

In all cases, the crop seemed to do best if the ground was manured the second year before the season the beet is to be raised. Well-rotted stable manure to be plowed under is advisable and in Nebraska results in greatly increased tonnage. In Utah, on the other hand, there has been a disposition among growers to put too much manure on their land, obtaining tonnage at the risk of quality, because beets of such gross growth do not ripen well. Even on the apparently inexhaustible soils at Chino, fertilizers have proven effective. "Green" or fresh stable manure should be plowed under the previous fall; better still, apply it to the previous crop. The main point is to have the soil well filled with available plant food in proper forms.

Elaborate experiments have been conducted along this line in Europe on the old soils of Europe, which Wiley thus summarizes: "As for the relation which the quantity of material returned should bear to the quantity abstracted, it may be said in general that it is desirable to return as much nitrogen, one and a quarter to one and one half times as much potash, and two and a half times as much phosphoric acid as has been abstracted. The greater additions of potash and phosphoric acids have no disadvantageous effects upon the crop. Direct investigations in regard to the relation between the sugar and potash in consecutive crops for many years have failed to give the least ground for a contrary conclusion. But it must not be expected, on the other hand, that increasing fertilizations, especially potash fertilization, will produce proportionately increasing crops, as has been asserted by some.

"The opinion has generally prevailed among beet growers during late years that heavy nitrogenous manuring, especially with nitrate of soda, produces no injurious effect on the quality of the beet. This opinion was based on the fact that in such beets the sugar per cent was only slightly diminished. Nevertheless the quality of a beet may be impaired even with little or no diminution of the sugar content by reason of the increase of the percentage of non-sugars present. It has been shown that heavy manuring with nitrogenous substances greatly injures the quality of the beet for sugar-making purposes."

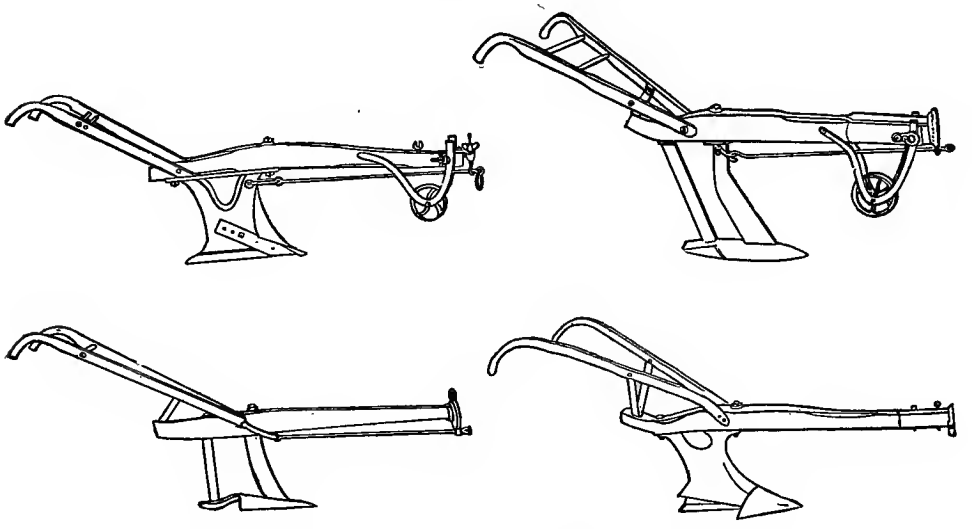
It is true that the beet is not an exhaustive crop, provided all its by-products are returned to the soil, but we fear that this will not be done in America for some years, meanwhile there is danger that failing to thus restore to the soil what is taken from it, farmers may get the idea that the beet will not exhaust the land, and that it can be grown in defiance of the fundamental principles of agriculture. This error should be guarded against by liberal fertilization.

PLOWING.

Immediately after harvesting the small grain, plow shallow (two or three inches) in order to prevent the weeds from going to seed. When this is done, spread the field with stable manure (if any is to be used) and in the fall plow deep. This deep plowing is very important, because the beet is thereby enabled to penetrate into the subsoil without much obstruction, thus preventing it from growing out of the ground and allowing it to extract considerable nourishment from the lower soil. The deep plowing will also give clean ground and will make it ready for early planting and thus insure a large tonnage. The best way to accomplish this is to plow 8 to 10

inches deep with an ordinary plow, follow it with a good subsoil plow that will stir the subsoil to a depth of 5 to 7 inches more, thus giving an open soil to a depth of 14 to 17 inches. This subsoiling is often neglected, but it is essential for two reasons: (1) It gives a deep soil for the beet root to grow down into draining its food from the lower depths, and also preventing the top of the root from growing out of the ground; this makes a smooth conical beet of moderate size, richest in sugar and easily harvested. When the land does not freeze, as in California, this plowing should be done two or four months before seeding.

In case the plowing has not been done in the fall, plow as early in the spring as the ground will do to handle without sticking, for three reasons: 1, Because the sooner the weeds are encouraged to grow, the more of them can be killed before planting the beets; 2, because land plowed while the weather is cool will retain the



OTHER STYLES OF SUBSOIL PLOWS.

moisture much longer than it will if plowed during warm weather; 3, because it is much better to allow the ground to settle as much as possible after plowing and before the preparation of the seed bed, so that it will become thoroughly packed, thus insuring better and quicker germination. In the spring never throw up more than two inches of soil that has not been stirred before; if your soil has never been plowed over six inches, it is better to use a subsoil plow to loosen the ground to the proper depth. These instructions refer only to spring plowing; when good land with deep soil is plowed in the fall it makes little difference how much new soil is turned up, as it would decay in winter through the action of the frost, but on thinner soils, this trouble can always be obviated by the subsoiler.

After spring plowing, harrow, or better, drag once immediately, and then leave the ground as it is until the time to prepare the seed bed, thus allowing the weeds to sprout. If the previous crop was corn, it is absolutely necessary to take the stalks and roots off the ground in the right manner in order to permit of easy and proper

horse cultivation; it will not do to plow the stalks under, however, as it cannot be done effectually, the cultivator-knives bringing them back to the surface once more, and at the same time dragging along with them more or less of the small beet plants. The best way is to remove the mold-board from the plow, which will enable you to loosen the roots without turning the cornstalks under. Then gather them up with a hay rake into piles and after burning as much as possible haul off the remainder.

In many soils in California, a sour clay is brought to the surface by deep plowing, which is injurious to the beet because of its acidity. This should be neutralized by the use of about two tons of lime per acre broadcasted on before harvesting. In California, the spring cultivation of the plowed land is done with an implement furnished with long, narrow teeth that reach to the bottom of the plowing.

MORE ABOUT SUBSOILING.

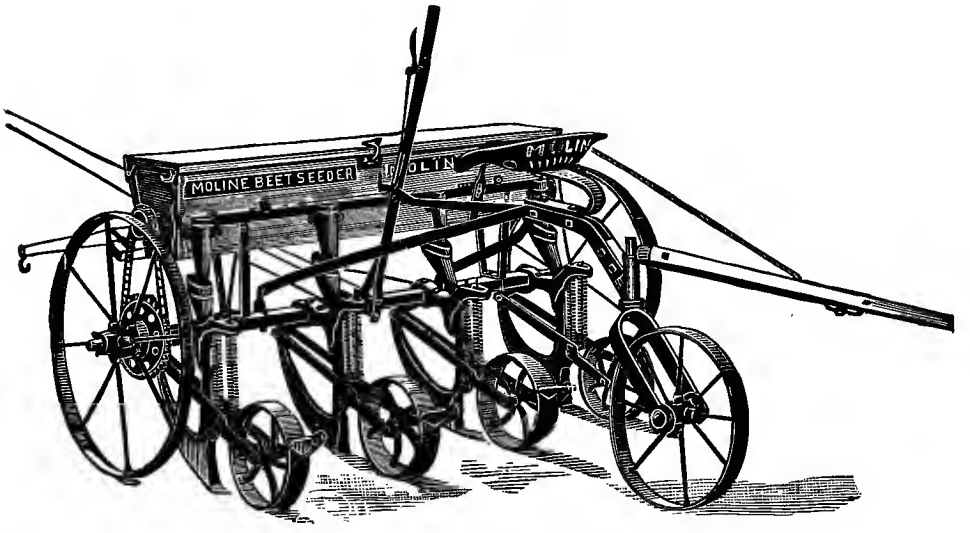
This work is so important, especially in drouthy regions, that more detailed discussion of it is in order.

Subsoiling consists of a loosening or a breaking up of 8 to 20 or more inches of the soil below the depth of ordinary plowing. In true subsoiling the lower layers of soil are not thrown out on top. When the prairies of the west were first plowed, it was sometimes thought desirable to break the sod very shallow; then by following in the furrow, with the plow so made as to throw the comparatively mellow second furrow on top of the first, a layer of loose ground was obtained in which seed could be planted. This so-called subsoiling is in reality nothing but deep plowing, and is practicable only in a new country, or in the breaking up of meadows or pastures which have an exceedingly compact turf. In practice, land to be subsoiled the first time is plowed to the accustomed depth. The subsoil plow follows in the furrow of the ordinary plow, and is run about eight inches deep. If it is thought desirable, the work can be still more completely accomplished by subsoiling crosswise, running the subsoil plow the second time a little deeper than during the first operation. The entire subsoil to a depth of 12 to 14 inches, depending upon the depth of the first plowing, is thoroughly loosened, and so broken up that plant roots can easily penetrate it and rainfall is readily absorbed. When the same land is subsoiled again, run the plow about four inches deeper.

The main benefits derived from this practice are: 1, The upper layers of soil are broken up and placed in a condition to absorb and hold a maximum amount of water. 2, Natural rainfall is taken up and retained until needed by the growing crops. 3, Heat and air are enabled to permeate the subsoil and render available the plant food contained therein. 4, The loosened ground acts as a vast reservoir for storing soil moisture. 5, Stirring the hard subsoil breaks up the capillary tubes and prevents wasteful evaporation. 6, During the wet season the openings made by the subsoil plow allow the excess of water to escape to lower levels. 7, Plant roots are given a better opportunity of development. 8, Such crops as sugar beets, turnips, rutabagas, sweet potatoes, etc, develop more completely under ground, resulting in a higher grade vegetable. If the surface of the field is kept loose by shallow culture, the loose layer will act as a mulch and greatly aid in retaining moisture. Experience and ob-

servation have shown that the season, wet or dry, warm or cold, determines whether crops will be heavy or light. Any treatment, therefore, that will counteract the uneven conditions of a season, even partially, will increase the yield. Subsoiling and surface cultivation have a marked effect in counteracting the disastrous results of drouths. The benefits of subsoiling, however, will depend almost altogether upon the nature of both the surface soil and that lower down.

Where the subsoil is very loose and porous, subsoil plowing may be a decided disadvantage, in that it forms larger passages through which the natural rainfall will escape. If it is not a disadvantage, it often is of no benefit from the fact that the subsoil is already sufficiently loose to retain the greatest amount of moisture. Fields



ADJUSTABLE FOUR-ROW BEET SEEDER.

This machine plants 15, 20, or 25 lbs. of seed per acre in rows 16, 18 or 20 inches apart as desired, covers the seed to an even depth, and firms the soil about the seed. On large areas such a machine is indispensable.

underlaid with a compact subsoil or hardpan, or those which have been plowed at the same depth for a number of years, forming a hard layer at the bottom of the furrow, are the ones chiefly benefited by this mode of culture. This practice on any kind of soil, unless it is hardpan, would obviously be unnecessary during seasons when rains are sufficiently frequent to furnish the necessary moisture for growing crops. During wet weather the operation might result in a puddling of the soil, to its great injury. It is only during very dry seasons when its full benefits would be seen, but for the past 10 or 12 years in the most prominent grain and vegetable producing states, there has occurred in the summer or early fall a drouth which very materially shortened the crop. So true is this, that farmers and gardeners in states comparatively free from severe drouths have begun to seriously consider some method of bridging over this disastrous period, especially injurious to the market gardener and fruit grower. In practice it has been found that unless the soil is unusually compact,

treatment once every three or four years is amply sufficient. With increasing drouths, however, it may be found desirable to subsoil every two years. The work is most profitably done in the fall, as this gives an opportunity for the land so treated to absorb the fall rains, winter snows and any moisture which may be precipitated before spring plowing is possible. This is specially true in parts of the far west, where winter irrigation is practiced. The streams there during early fall or winter usually supply sufficient water for irrigating, while during the dry season they fail.

Admitting, then, that subsoiling ought at least to be tested, the question of obtaining suitable and most desirable plows is important. The common practice, as before stated, is to follow the ordinary breaking plow with a plow constructed especially for subsoiling, types of which are illustrated herewith. These cost all the way from $10 to $18. They can be obtained of any of the prominent plow firms. One company manufactures an attachment, or rather a subsoiler, which is substituted for the front plow on a four-horse gang. There is no getting around the fact that subsoil plows pull hard. In the case of the gang subsoiler, a good four-horse team takes it along quite readily, but if the ground is especially hard, it would need one or two extra horses. With the ordinary subsoiler, which follows in the furrows of the plow, it is customary to use two horses, but three or even four are more satisfactory.

During the past four years many careful tests with subsoiling have been conducted at American experiment stations and by practical farmers. The results, carefully compiled by Mr C. A. Shamel in AMERICAN AGRICULTURIST, are somewhat conflicting, though only a few were with sugar beets.

In New York and Kansas no decided advantage was obtained. In South Carolina on sandy soils, the effect was not appreciable. In Indiana and Iowa, the practice was advantageous in sugar beet culture, as better formed beets, with a higher per cent of sugar, were obtained. Corn in these two states was not benefited. Practical farmers in Kansas find subsoiling beneficial. Mr Kelsey of Oakland, Shawnee Co, stated to the agricultural board that in 1894 land subsoiled yielded 65 bu of corn, while that not so treated produced only 35 bu. Millet on subsoiled land yielded well; on untreated it was a failure. The effects last about three years. Subsoil one-third of the farm each year. Mr Peckham of Haven, Reno Co, obtained substantially the same results. Experiences in Illinois are somewhat difficult to obtain, as but little work has been done along this line. In general the facts in this state agree with those from Kansas and Nebraska.

The most marked results are reported from the Nebraska experiment station in Lancaster Co, by Prof Lyon. The soil in most parts of Nebraska, and where these experiments were tried, contains very little sand and is made up mostly of silt, or of the ordinary dark mud so familiar to residents of the corn belt. Because of the small amount of sand, the soil compacts quite readily, becoming almost as firm as so much clay. It is well supplied with plant food, and when stirred sufficiently deep so as to take up water, is very productive. Good results from subsoiling were very marked. Land subsoiled four years ago for sugar beets and not treated since, was this season planted to corn. A field not so treated lay alongside. Both were upland, with a gradual slope toward the east, and consisted of a fine loam with considerable vegeta-

ble matter. The results were so marked that the exact row of the subsoiled field could be told, because of its superior excellence. The stalks on the unsubsoiled land were badly dried up and contained no ears, while those on subsoiled land were large, green, and produced a fair yield. Such results are encouraging, and show that with very little extra expense good crops can be raised with less rainfall than is generally supposed. If the effect is not apparent the first season, it makes itself felt in the course of two or three years, the reason being that if very little rain falls after subsoiling, the small amount of moisture sinks rapidly into the soil and is retained there until the plant roots need it. After the practice has been started, the excess of water beyond the demands of the soil continues. Subsoiling is especially adapted to Nebraska, because the annual rainfall is less than in most arable portions of the coun-

A HAND PLANTER FOR BEET SEEDS.

Smaller drills like the one illustrated have been used with satisfaction, but this new No. 5 drill is still better and larger, while so simple as to insure the most even seeding and covering. It can be regulated to drop any desired number or weight of seeds, at varying distances apart, or in hills; is equipped with marker.

try. Added to this is a very dry atmosphere, and periods of extreme heat accompanied by high winds. The following conclusions were reached for Nebraska: Subsoil plowing, although conserving moisture, does not produce it and is therefore not a substitute for irrigation where rainfall is too small to produce crops. Where the subsoil is hard, subsoiling is recommended; when loose it is not profitable and may be injurious. Do not subsoil when wet, as there is danger of puddling the soil, thus leaving it in a worse condition than before. Ground subsoiled in the fall has an ample opportunity of absorbing the greatest rainfall. Subsoiling in spring may be detrimental in extreme dry weather, as the water is partially removed from the young plants by the absorption of the dry bottom soil.

PREPARATION OF SEED BED.

Land that has been fall plowed must be harrowed as soon as the frost is out of the ground and the soil is dry enough to prevent sticking. This work will level the

ground, thereby holding the moisture in the soil, and increase the germination of the weeds, etc. To secure a good crop, it is absolutely necessary to kill all the weeds in the ground before seeding. Here is where most failures occur, and if weeds are allowed to get a start, the cultivation of the crop will involve much unnecessary and expensive hand work. Therefore, to prepare a good seed bed, we advise working the soil four to five inches deep with a pulverizer, or better yet, with a corn cultivator, once lengthwise and once crosswise, making sure not to miss any spot in the field, as it is necessary to loosen any weeds that may have already sprouted. In California this has to be done whenever the weeds may start. Then harrow lengthwise and crosswise to level the soil perfectly and finish killing the weeds. After this, pack the top soil to a depth of two to three inches well with a heavy roller; never use a plank float for this work, as floated ground is never well packed, and will besides increase blowing and washing. The better the soil is packed after the weeds are killed, the better the beet seed will sprout. All the above work must be performed at a time when the ground is in good working condition; that is, not too damp, as the working of wet soil must be strictly avoided. As beet seed requires considerable moisture to germinate, it would also be a great loss to the beet grower to allow the soil during the preparation of the seed bed to dry out; therefore in dry weather or in an average season, the field must be prepared and seeded the same day, this being the only way in which the moisture can be kept in the ground under the usual west conditions—a great feature in crop raising and especially so in beet culture.

To prevent the soil blowing, which is very disastrous to the small beet plants (in Nebraska, even the best black bottom land will blow, if level and fine, which it must be to secure a good crop), run a light harrow over the field, after rolling but before seeding. This harrow must be very light and can be easily constructed and without much expense by using 2x2 pine pieces for the beams and large nails for the teeth, only letting them project below the beams 1½ to 2 inches. This harrow must simply scratch the soil (not over half an inch deep), thus giving a rough surface, which will prevent blowing except on dry, sandy soil, on which, for this reason and some others, sugar beets should never be planted. The soil must not be loosened again by a deep harrowing, as this would injure the germination.

There is a tendency to neglect some of these various preparations of the soil, but except on certain lands particularly adapted to the crop, every step above enumerated is essential. Too much care cannot be devoted to the preparation of soil and seed bed, for upon it success largely depends. Even if the season is unfavorable, the crop will do enough better on a well-prepared soil to pay for the labor, while in a favorable season, this work will yield a handsome dividend. It will be seen that such preparation is directly contrary to the careless way in which the land is usually worked for field crops. Right here is where beet culture differs from that of almost any other crop. It involves intense farming of the highest type. Not one of the old market gardens about New York, Philadelphia, or other eastern cities is more carefully worked than the sugar beet requires for best results.

SEEDING.

To secure a full yield, it is absolutely necessary to have a good stand. It is much easier to thin out surplus beets with a good stand, than to have to plow under the

entire patch and replant it in case of a poor stand. It is desirable that when the plants come up they should nearly touch each other, but there is no necessity of overcrowding, as this occasions extra labor in thinning out. Or the seed may be planted at a distance of three or four inches in the rows in groups of three or four seeds. Formerly only 10 or 15 pounds of seed per acre was sowed, but American experience during the past six years has emphasized the importance of sowing at least 20 lbs of seed per acre. Then, should the weather be dry, the best seed will come up first and there will be enough for a good stand. On the other hand, should a crust be formed on the field after a heavy rain, one plant would help the other to break through the

PLANET JR. NO. 11 DOUBLE WHEEL HOE CULTIVATOR, RAKE AND PLOW.

ground. It is easier to do a little extra thinning than to replant. If seeding a small patch by hand, less seed will be required if the work is done carefully.

Almost any garden drill can be adapted to sowing beet seed, but for larger fields the four-row horse drill is used. Seeders made especially for this purpose, seeding four rows at a time and dropping the seed continuously in rows 14 to 19 inches apart, (according to the fertility of the soil) will plant 10 to 12 acres per day. Never plant over three-fourths of an inch deep, but see that the earth is well packed around the seed by the press wheels attached to the back of the drill, because by pressing the surface the necessary moisture for germinating in a dry season is drawn by capillary attraction out of the deeper soil. The heavier the soil and the earlier the planting, the shallower must the sowing be in order to prevent the seed from rotting in the ground. The deeper the seed is planted, especially in heavy soil, the weaker the

plants will be if they come up at all. Therefore avoid deep planting, which invariably gives a poor stand. The least covering of moist earth, well packed about the seed, is sufficient to sprout it.

The rows may be 10, 12 or 14 inches apart if it is intended to weed out by hand; or 18 to 21 inches if the horse hoe is used.

Time for planting is when the soil is warm enough to germinate the seed. This is usually about two weeks or so earlier than the average farmer would think of planting corn. In California it may be any time from January to June, in the central west from April 20 to May 20, further east May 1 to June 1, and for the south March 1 to May 1. No hard and fast rule can be laid down; the intelligent observer can judge from the seasou and condition of soil. The young plants should show in 7 to 21 days, according to the season. If the stand is poor, cultivate it out and reseed the whole field; or replant the poor spots.

Parties growing a large acreage and not having very much help, will do well to plant the crop in sections, at intervals of one week apart, in order to gain more time for thinning; however, do not plant too late, for in that case the beets will not be strong enough when the dry season sets in, and will therefore suffer from the drouth, while the earlier and consequently stronger plants will thrive well and a heavier and better crop be insured. You had much better hire help during thinning time than to plant too late.

If beets are planted at great distances apart, they become large in size and freely absorb salts from the soil. To avoid this it is necessary to plant close together, thus dividing the available salts in the soil. Sugar is largely formed in the beet from the air through the leaves, and these should be many in number and of fair size, hence it will not do to overcrowd the plants.

CULTIVATING.

This work is performed with one-horse cultivators, which work one, two or four rows at a time. If after sowing, a heavy rain should cause a crust to form on the field, the light harrow previously described to prevent soil blowing is recommended; but this only in case the seed has not germinated, as otherwise it would be better to run the cultivator over the field, following the rows, which can be done easily before the seed is up, as the marks of the press wheels can be plainly distinguished. This work, however, can be better done by hand hoes (11 inches wide; see Hoeing). As soon as the beets break through the ground and the rows can be followed, the cultivation must begin, the earlier the better, not only to destroy the weeds, but to loosen the soil, which permits the air to penetrate, thus forcing the growth of the beet and improving the quality.

It is very important to kill the weeds before they get above the ground, or at least before they become well-rooted. This can be easily accomplished by cultivating the field with the flat shovels every eight or ten days, care being taken to set the knives as close as possible to the rows, and never over two inches from the rows as long as the beets are small. As the beets grow older, however, the shovels should be run gradually farther away from the beets, and also deeper, until the leaves meet in the center of the rows, by which time the cultivation should have reached a depth of

6 inches, and should then cease, as the beets are ready to lay by. Besides destroying the weeds, this repeated cultivation prevents evaporation from the deeper soil, and secures a good and healthy growth. Never hill the beets, as level land keeps the moisture best.

Keep the horse cultivator going whenever weeds appear, or a crust forms, until the beets have grown so large as to prevent this work, when they may be "laid by." In Utah and California, four cultivations and one hand hoeing, besides one spacing and thinning, is all the crop requires, but in Nebraska winds and drouth may necessitate more work on the crop. Frequent stirring to a depth of two or three inches is one of the best means of preventing loss of moisture from below during a dry spell. This point cannot be too carefully observed whenever a drouth threatens, and if this cultivation is well and frequently done, the crop will stand quite a severe drouth without much injury, if the ground was previously prepared as described on Page 83.

Hoeing has been rendered more effective and less expensive by the use of the various horse hoes and cultivators illustrated, but the use of these machines is to be supplemented in the field with the hand hoe. Great care must be exercised in using any cultivating machine, for if the setting up and use be not carefully looked after, the weeds will not be extirpated, while whole rows of beets may be cut down. Frequent hoeing and cultivating cannot be too highly recommended, for, as they say in Germany, "sugar is hoed into the beets." In Knauer's experience (Germany) a plot hoed once yielded 7 tons of beets per acre, twice gave 8 tons, three times gave 10¾ tons, four times gave 12¼ tons, while a field hoed five times yielded over 13 tons of dressed beets per acre, thus doubling the yield over the plot hoed only once.

It will be seen from the foregoing that flat culture and rows is the universal rule at present in America. Mr Lewis S. Ware, editor of *The Sugar Beet*, states in that paper for January '97, illustrating a French machine for harvesting beets in hills: "We have on many previous occasions urged that hill cultivation should be given a fair trial; it enables the tiller to get from beets most satisfactory results. The objection, evidently, is that special agricultural implements are needed. In Europe, the rows on hills are either single or double; when single, the harvesting with ordinary plow may give good results, but it is very much more expensive than it would be with a special double row harvester. When in single rows on hills the distance between rows is 21¼ to 23½ inches; when in double rows on hills the distance is 9 to 11 inches, while the hills are at distances which vary from 27 to 31 inches. There can be no doubt as regards the yield in hill cultivation; it is equal and, in many cases, is superior to flat cultivation, as the roots in growing find less resistance to overcome and have their plant food within easy reach, and through the soil there is a better circulation of air; furthermore, there need be no evil effects from badly drained or damp soils which, under ordinary conditions, are almost worthless."

This point is worthy the attention of American growers, though the fact that flat culture and drills have thus far been universal, indicates that they are generally satisfactory. One thing is certain, that hilling should not be practiced on dry and warm soils, for there it can only work harm. Hilling up may be of benefit on cold and wet soils, but these are properly treated by drainage. Of course if the soil gets washed

away from the plants, the earth should be drawn up about them, as that portion of the beet that shows above the soil is of inferior quality.

HOEING.

The first hoeing, which is very important for the growth of the small plants, must be given with an ordinary 11 inch hoe between the rows, going 1½ to 2 inches deep, and as soon as the beets break through the ground, or if crust is formed, as soon as this occurs, following the press wheel marks.

As the ground will have become packed during the bunching (or spacing) and thinning, thus preventing proper circulation of air, and the young plants, moreover, will have become weakened by their disturbance; and for the further reason that it is cheaper to do it then, the second hoeing should be given with a 7-inch hoe the day after the beets are thinned, and never later than a few days after, care being taken to kill the weeds out close to the plant, but in such a manner as not to loosen or injure the beets. As the horse cultivator only loosens and clears the ground between the rows, the hoe must perform this work between the different plants. This hoeing should be 3 inches deep. A similar hoeing may be necessary twice after this, the last depending upon the freedom from weeds, also upon whether the ground is loose enough to enable the roots to grow. Both of the last hoeings should be as deep as it is possible to make them without injuring or loosening the plant. Under ordinary circumstances no work should be necessary in the field after 80 days from the time of planting except the final and deepest horse cultivation.

THINNING OUT.

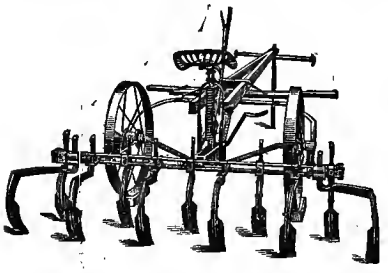
Care should be exercised in doing this part of the work, as it is the most important of all the cultivation and care of the crop. It can only be neglected at the expense of yield and quality of crop. It is very necessary that this should be done just at the right time, and the sooner it is done the better for the growth and yield of the crop. As soon as the beets have four leaves, they should be thinned, and must not remain longer than one week without thinning, as the roots will entwine around each other if left longer, and make the thinning detrimental to the plant that is left. To perform this work, the beets should be spaced or bunched (directly after a horse cultivation) with an ordinary 6-inch hoe, cutting 6 inches of beets out and leaving a 2-inch bunch, containing from three to six beets. After the beets are bunched, the healthiest plant in each bunch is selected by the thinner to be left standing, his finger is placed firmly against it to prevent its being disturbed, and the other plants are pulled out by hand, together with all the weeds nearby. This operation will leave one strong single plant every 9 or 10 inches, and the ground should be pushed up well around each, but not packed. Of course, it is better to select the strongest and most thrifty plant, even if it is not at the regular distance, than to chose a weakly or spindling one at just the right distance.

If thinned when only four leaves are on the plant, the top soil is still moist, and the beets left have no difficulty in taking hold and growing with renewed vigor, but the disturbance occasioned by thinning a few days later is not so easily overcome. The top soil is then dryer, and the young beet receives a set back that will certainly

DOUBLE TRACTION ENGINE SYSTEM OF STEAM PLOWING FOR SUGAR BEETS

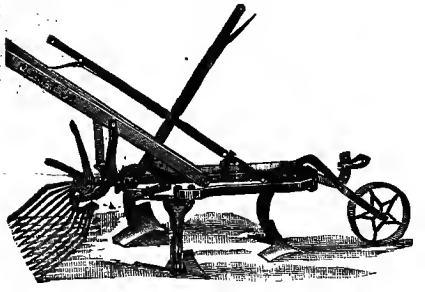
As operated on Ranco del Halle, Alameda county, California. The method in detail, and its remarkable results in increased tonnage and richness of beets, are fully treated in Part Four, Chapter IV.

affect the yield. Where weeds or insects are not to be feared, the spacing may be done a few days before thinning. On the other hand, if there is any reason to fear loss of the young plants, it is more prudent to wait a little longer before doing the work of spacing, and in this case thinning should follow spacing without any interval. If the land is very rich, the final plants are left as near together as 6, 7 or 8 inches, while in Utah, under irrigation, the plants are even thinned to 4 inches. The distance apart at which the beets are left depends not only upon richness of the soil, but upon the probabilities of its having sufficient moisture. In the rich moist land the beets can stand closer together than on dryer and lighter soils. By spacing with a hoe a more regular distance is secured between each beet, and all the weeds in the row are destroyed at the same time; the crust is also broken up that has been formed by the pressure of the wheel of the seeder, and it removes any seeds from the row that may not yet have germinated, thus avoiding, when harvest time comes, the appearance of a lot of small beets that had grown up from these seeds. This spacing with the hoe is also apt to increase tonnage and percentage of sugar.



PLANET JR. TWO-HORSE CULTIVATOR.

The leaves of the plant are the means through which it obtains most of its sugar. This substance is composed of carbon and oxygen, both of which are mainly taken in by the leaves, the former as carbonic acid. Mr Ware, in his great work on the sugar beet, summarizes experiments by himself and others to show that the saccharine content of the beet improved with the number and weight of its leaves. "Each leaf has apparently communication with a given portion of the beet, and supplies it with the nourishment it requires. The outer leaf corresponds with the inner portion of the root; these representing the older leaves, we may conclude that they have furnished the larger portion of the saccharine elements. During the growth of the leaf, the root increases but comparatively little in size, and as soon as completed, the contrary action takes place. Evidently, the greater the size of the leaves, the larger the amount of the elements they are able to abstract from the surrounding air, and the total weight of the leaves is, up to a certain period, greater than that of the root."



ANOTHER FORM OF CULTIVATOR.

This admirable Planet Jr. tool as a beet horse hoe, has a one and three-fourths inch cultivator tooth, two six-inch hoes, a twelve-inch special flat sweep, and a pulverizer. The latter is a very useful attachment, leveling and fining the surface and killing small weeds.

The smooth and tapering shape of the root desired depends mainly upon the soils where it grows and the preparation the soil has received. The variety of seed used has of course some influence on shape of root, but the most desirable seed for this

WEEDING OUT THINNED BEETS FOR THE LAST TIME.

Photograph of 40 acres of beets at East Norfolk, Nebraska. This plot of beets is a perfect stand, and in another week will be "laid by," not to be disturbed until harvest time.

purpose will not give roots of satisfactory form on an unfavorable and poorly prepared soil. It is senseless to blame the seed for faults in the soil.

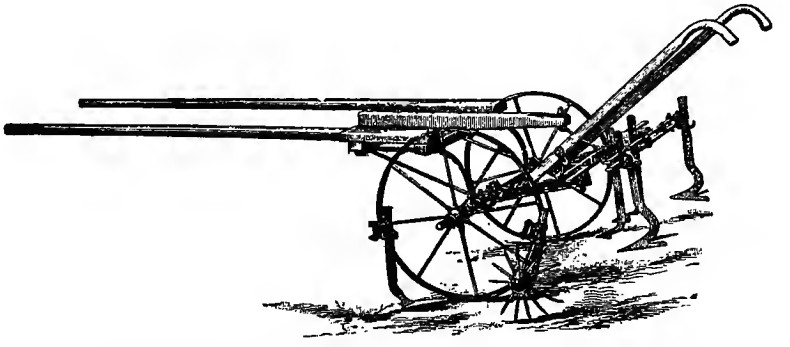
IRRIGATION.

Utah has solved the problem of growing beets by irrigation. Her experience teaches many practical lessons that are being heeded in drouthy or irrigation regions. Too much water, applied too often or at the wrong times, is bad for tonnage and quality. Great damage is done to many fields of beets by inexperienced farmers flooding the land and allowing the water to stand about the small plants, then neglecting to cultivate until the soil has baked. Even in Utah, it is still recognized that the management of irrigation to produce the best results is a delicate matter, and not yet fully understood. Untimely irrigation may utterly destroy the value of the roots for sugar making, and the necessity of varying the application of water according to the nature of the land, in order to secure good results, implies the exercise of much judgment and experience in the matter. But with due regard to all these alleged disadvantages of irrigation, it is the universal judgment of Utah beet growers, after six years' experience, that they are far outweighed by the benefits of irrigation. The production is more certain, and the harvest more safely assured, than where the caprice of heavy rains or excessive drouth has to be contended with. The results are always more certain where irrigation is necessary and this is the greatest stimulant to proper methods in applying water.

Mr George Austin, field manager of the Utah Sugar company, has had more experience than any other man in growing beets by irrigation. Mr Austin says: "After the thinning is done we run a cultivator drawn by a horse through the rows, but great care must be taken not to cultivate too deep or hill up the young plants, as they require all the air and sunlight that it is possible for them to have. After the first cultivation we generally hoe them the second time to clean out all the weeds in the rows and remove any surplus beets that may have been overlooked at the time of thinning. By this time the beets should be far enough advanced to commence preparing for irrigation. This we do by using the same cultivator, attaching a small 6-inch furrower on the rear end, and we cultivate every other row, leaving a nice little ditch of sufficient size to carry the water without flooding the beets. The second watering we alternate the rows—this method usually gives enough moisture each watering, but this kind of irrigation, however, depends entirely on the slope and condition of the land. If the land has much of a slope, and is inclined to be a light, sandy loam, it may be necessary to water each row every time you irrigate during the season, but the latter is an exception to the rule with us.

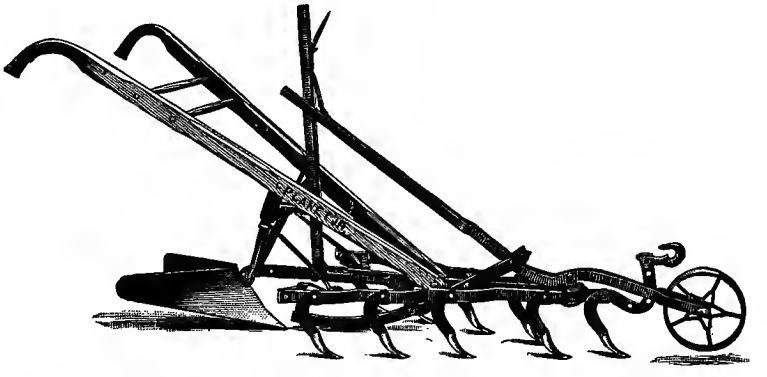
"We never commence irrigating until the beets show they require moisture, (usually letting them suffer a few days), and by so doing it always gives us a nice shaped, long, tapering beet. If the first watering is applied too early we usually have a short, spriggy, undesirable beet. Too much manure or alkali will have the same effect on sugar beets. We generally have to make cross ditches on our beet fields on about every 20 to 30 rods, depending upon the slope and nature of the land. If we run the water farther than this it usually saturates the upper part of the field too much, before the lower end gets sufficient. Great care must be taken in turning the

water on the beets not to force too much into the furrows, causing it to flood or overflow, and this must be avoided if possible. Therefore it is essential to select land for this crop, as much as possible, with a nice slope. We always cultivate the rows after each watering as soon as we can, cultivating them from 5 to 6 inches deep. This allows the beets to develop, and also helps to retain the moisture much longer than it would



FREMONT SUGAR BEET CULTIVATOR.

This Nebraska invention is the result of several years' work in the beet fields of that state. The machine is simple, light, compact and easily adjustable for either deep or shallow cultivation. The four spiders provided are used in case the soil becomes crusted on the surface, thereby preventing the beets from showing through the ground. There are four knives that are used in cultivating the beets when very small. These are different from any used heretofore, and are so shaped as to permit the party handling the machine to work very close to the plant without danger of covering the plant with dirt. The four small shovels are used for the deeper cultivation, and the two large shovels are for the final and deepest cultivation.



PLANET JR. BEET GROWERS' HORSE HOE.

This machine has been perfected by Utah experience, and is very popular there. The teeth loosen the soil thoroughly without throwing earth on the small plants. The little plow at the rear is the "Irrigating tooth," to make a clean furrow through which the water will run for irrigation.

otherwise. Care must be taken all through the season not to hill up the beets, or break off the leaves. We generally water our beets two to four times during the season, and it usually takes about 20 to 30 days after the last watering before the beets are ready for harvesting."

Mr Morgan Woodhouse, another Utah grower of experience writes: "My idea is to let them go as long in the spring without water as you dare, say until the bottom

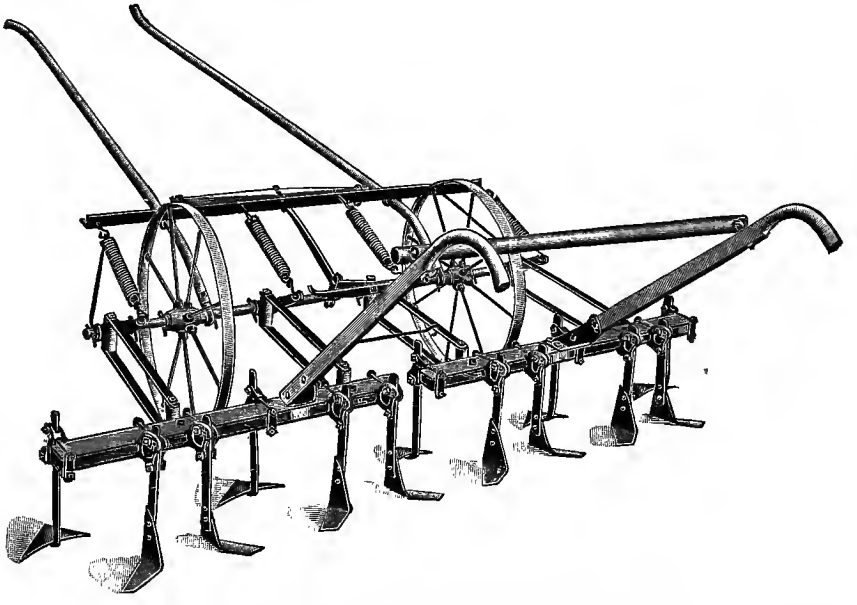
leaves wilt down and the tops begin to change from a light or yellowish green to a dark green. After the first watering they should be kept wet. I would not be in favor of going to an extreme, but I would not allow them to get dry if I could help it. The length of time between waterings should vary, according to the land, from 8 to 14 days. The last watering should be about the last of August or the first of September."

Another expert, Mr Samuel Taylor says: "I do not believe it is good to irrigate too soon. Let your beets get up and get them thinned, letting them have a pretty good start. When the lower leaves begin to wilt and the tops turn a dark green, the water should be first applied. Of course when you start you must keep it up. Three or four waterings will make a good crop of beets. Four are better than three, and if you can get four good irrigations on a crop of beets I am satisfied they will mature and make a good crop. With respect to the last watering; one year we were told to stop watering too early and we lost a great many beets by it. I would water the last time about the last of August, if watered up to this date the beets will be all right."

In Nebraska it is felt that proper irrigation will often insure the crop, but experience has so far been limited. Mr F. Wietzer, field manager for the Norfolk factory, summarizes the matter for this work as follows: "We have taken much interest in irrigation of sugar beets. Last year there was raised 90 acres by irrigation, and the results were very satisfactory, as well in quality as quantity. Beets should never be irrigated until they show actual need of it. No water should be put on them as long as there is a natural supply of water in the ground, for too much water is almost as disastrous as not enough. After you have once commenced putting water on land, it dries out more quickly than before and will require watering the second time. The number of irrigations that a crop requires during the season depends entirely upon local surroundings, nature and condition of land. The first irrigation should not be before the middle of June, and no water should be applied after the first week in August. Beets should never be irrigated in the fall, for irrigating at that time will bring forth new tops and give the roots a second growth, which is disastrous to the quality. A very advantageous method of irrigation is this: When the spring is very dry, to soak the land from the irrigation ditches, and then as soon as the soil is dry enough, prepare seed bed and plant seed."

Mr Granger, field manager of the Utah Sugar Co, spoke of irrigation at length in his address before the Pecos valley beet growers in New Mexico. Among other things he said: "As soon as you have commenced irrigating, see that the beet is kept supplied with sufficient moisture to keep it thrifty. It will take thirty days from the last irrigation before you can harvest, usually; on very sandy land twenty-five days, on clay land thirty days. This delay is necessary because, when you are through irrigating for the last time, the beets are nearly through growing and the sugar is forming. When given an irrigation, the sugar in the beets will go down for fifteen days, and it will take a little longer to get back again. A great many people ask me how many times they shall irrigate. I cannot tell them without seeing the field. When the leaves wilt down in the middle of the day it is not so bad, but when they stay wilted in the cool of the evening, give them a drink. Let them suffer a little for water in the fore part of the season; it will force the taproot to reach down for moisture. In

irrigating beets, we take every other row, and find that the water when run slowly will irrigate both. Then we alternate the next time, and run water through the other rows, giving the beets moisture on both sides. After every irrigation cultivate as deep as you can, practically eight inches. It is necessary to loosen the ground around the beet so that it may have a chance to develop. To do this we take a little A-shaped sweep, with the point running into the ground, and all it does is to lift the ground a little, but it loosens the soil around the beet. In Utah, our water is run to us in canals and ditches in which we are all interested, and have turns to use it. Only two or three nights before I left home, I found a water notice at my house, stating that the water would be given me at 8 that evening and taken off at 4 in the



THE MOLINE BEET CULTIVATOR

Can be used to work either four or two rows. The gangs are so adjusted that they can be handled with ease, and the shovels are so adjusted as to be run right up close to the beets. This cultivator is widely used in American beet fields.

morning. At 4, my neighbor is there, and he takes it. We never have more than 30 minutes to the acre in Lehi, and sometimes it is cut down to 15 minutes, during which the water is allowed us."

William Bone, Jr, another very successful beet grower for the Lehi concern, says: "I think beets can hardly have too much water at certain times, which can only be judged by practical experience. A great deal depends upon the season and the land, too. I would not water them until they show that they need it the first time. In naturally light land they will stand watering pretty early. They should have at least two good cultivations before they are watered at all. In regard to the last watering, my idea is with them the same as with any other crop. If you let any crop wither and die, it is not good for anything. It naturally loses its strength and vitality.

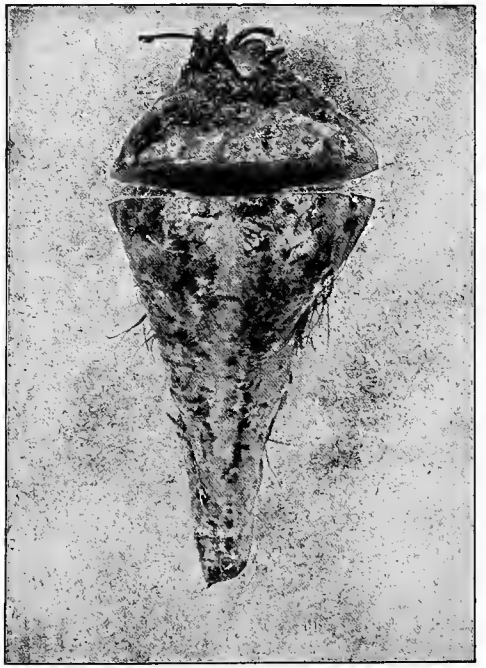
Water will not stop the beets from ripening, that is, unless the land is wet and clayey, and of course a person should know better than to water such land late in the season. Beets that have been well watered will not be affected nearly so much by the late storms as those that have not been well watered. My experience is that beets need some alkali, but I do not think that very strong alkali land is good for them. There is naturally more or less alkali in all our land, unless it is the light, loamy soil. Beets like manure. Even here in Utah, all our land needs manure for beets. Of course a person can go to an extreme, but as a rule all our lands need manuring. There is one thing more about preparing land for beets: I am sure that many of our people tramp their land too much. Some of it becomes packed very heavy before the beets are put in. After the beets have come up the land cannot be cultivated too much."

We may add that frequent and thorough culture is the best substitute for irrigation. With it, the beet will stand quite severe drouth. During the great drouth of '94, in the valley of the Platte, Nebraska, beets stood the drouth better than corn did, for the subsoil is of sand and the water is only 10 to 15 feet below the surface of the ground, so that the roots of the beets can almost penetrate to the water.

HARVESTING.

It requires about four and one-half to five months after planting to procure ripe beets, although in California the time varies from 120 to 160 days. After they have been in the ground that length of time, and the outer leaves turn yellow and die down, it is an indication that the beets are ripening. The maximum of sugar and purity is usually obtained during the month of October over much of the country where ordinarily severe winters are experienced, but in the Southwest and California, maturity on moist and late lands may not be reached until considerably later. The factory usually samples several fields before advising growers to enter upon the general harvest. As the beets increase in tonnage mostly during the last six weeks of their growth, the harvesting with full force should not be started too early. On the other hand, the beets must be out of the ground before hard freezing weather, as alternate freezing and thawing injures the sugar content. In case of a severe freeze before harvest is completed, it may be best to leave the balance of the roots in the ground for a few days until normal weather is restored, as the quick thawing out of the beets might seriously impair their sugar content.

The beets may be plowed loose from 8 to 10 days before removing from the ground, using a plow with a thin blade, which splits the soil between the rows. Instead of the share it has a narrow blade in the nature of a subsoil point, enough to carry it deep into the ground. The use of the plow avoids the injury to the beet caused by spades, hoes or shovels, and it is then easier also to remove the beet plant from the hard soil. Treated in this manner, the roots ripen and gain in weight and sugar; the earth adheres less to the root and can be shaken off with ease. In Nebraska, a two-horse puller is used (Page 105) which loosens the beets, but leaves them in the ground. Whatever method is employed, the tops are taken hold of by boys, who pull the beets and throw them into piles. Another set of boys cuts off the tops with a beet knife, and for this purpose, the point of an old scythe set in a handle is about as good a tool as one can use, or a corn knife. The topping is best accom-



BADLY TRIMMED, POORLY FORMED.

The loss in weight by such trimming is 33 per cent. The poor shape is due to improper preparation of the soil. The subsoil was so hard or other conditions so unfavorable that the root was grown mostly near or above the surface of the ground.

PROPERLY TRIMMED, IDEAL FORM.

This beet was grown in properly prepared soil, is ideal in size, shape, weight, sugar content and purity. The loss in weight by trimming is only 15 per cent. Bulletin 143, Cornell.

plished by a deep, straight cut across the beet without whittling, including the base of the rough portion of the top, from which the leaves grow

It is important that the top of the beet be cut off down to the neck so as to include with the top all that portion of the beet to which the stems of the leaves have been attached. "The object of removing this portion of the beet is to prevent the mineral salts, which have accumulated in large quantities therein, from entering the factory. These mineral salts exercise a very deleterious influence on the crystallization of the sugar, and therefore should be removed. They are well fitted for fertilizing purposes and are of more value when left upon the soil than when removed to the factory." These tops of the beets, with the attached leaves, are admirable for fodder.

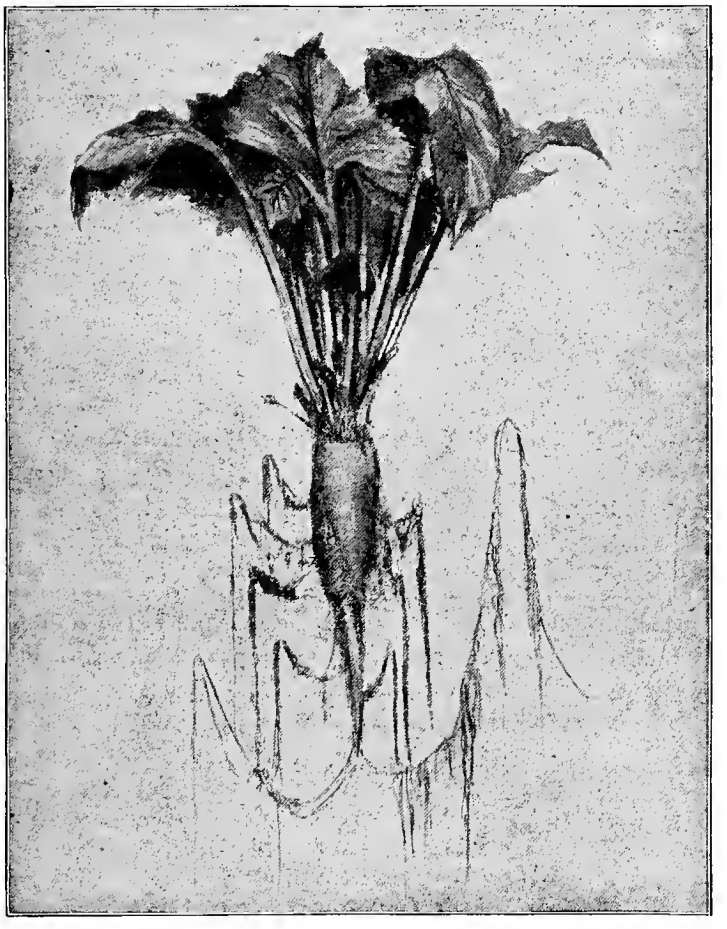
Another important point in harvesting beets is to have them as free from dirt as possible. When beets arrive at the Nebraska factories, an average 50 lbs is taken from each load. They are then thoroughly washed and examined to see if properly topped, then weighed again, the loss determining the tare. The greater the amount of dirt on the roots or the more improperly they are topped, the larger is the loss in weight or tare. The farmer not only has to stand this loss but he also bears the expense of hauling and handling this unnecessary dirt. Not only that, but the dirt adhering to the roots is the finest part of the soil and very often the richest and best portion, and in a few years, a surprising amount of soil is thus taken from the land. Some careful beet growers not only try to deliver beets as clean as possible, but instead of returning with their wagons empty, load up with the waste deposited from the washer at the factory, which contains not only the rich earth that has been washed from the beets, but also the tip ends of roots, etc, all of which possess fertilizing value of importance.

Several harvesting machines to both dig and top the beets have been tried but up to the past season, all have been discarded. Numerous clever and practical minds are at work on the problem and it is probable that a satisfactory machine to take the beets from the soil and top them will soon be perfected. There are several very successful machines for simply digging or plowing out the beets, several of which are shown in the accompanying illustrations.

The beets, after being topped, are then thrown into wagons, covered with sacking and hauled to the factory, or stored in silos in the ground. In delivering beets from the field to the factory, wagons hauled by horses or mules are usually employed in this country. It is a question, however, whether a more economical method is not possible, when the factory is in the midst of the beet fields. In this case, a movable railway with light rails and sleepers, that could be moved quickly and cheaply as the beets were harvested, would enable one horse to draw a car containing more beets than the ordinary two-horse wagon will carry. An overhead trolley upon which baskets of beets are drawn by ropes might be used, or on a large scale, where a factory is equipped with electricity, a movable overhead trolley employing electrical power to push the car along, might be feasible. Beets cannot be hauled by wagon more than from 4 to 8 miles without its costing more than the traffic will bear. Of course

where they are delivered to the railroad, the loaded freight cars are run by a spur track direct to the factory yard or shed.

Mr Ware says that "A great mistake made by many farmers is not to cover their beets as soon as pulled, for if left on the ground they may lose 6 per cent moisture in 24 hours. Place them in silos, if possible at once, until needed at factory. The loss of moisture can attain within a few days 20 per cent, the quality of the juice is not



THE MATURE SUGAR BEET.

Plant 150 or 160 days old, Vilmorin variety, with its root system, about one-twelfth natural size. This plate from Bulletin 44, Nebraska experiment station, evidently reduced one-half from larger plate in Bulletin 27, Division of Chemistry, United States Department of Agriculture.

improved, changes take place, and the manufacturer frequently has considerable difficulty in working such beets. The farmer loses, so does the manufacturer. A neglect of this kind is more serious than most American farmers realize."

STORING BEETS.

In the mild climate of California, the beets are dumped in large sheds at the factory, or are simply left in huge piles outdoors. The loss in sugar content seems to be

comparatively slight for a few weeks, and the beets are worked up before material injury occurs.

In the colder climate of Utah, where the temperature goes as low as in any part of the United States, it was formerly thought that the beets must be carefully stored in expensive silos or sheds. Hence when the Lehi factory was first built, the five frost proof beet sheds shown on Page 111 were built—of lumber, the walls being lined with straw. Each shed is 500 ft long and 26 ft wide, constructed with a sluice in the center so that the beets can be shoveled into it and brought to the factory by water, which is not only economy of labor but it gives them a thorough washing.

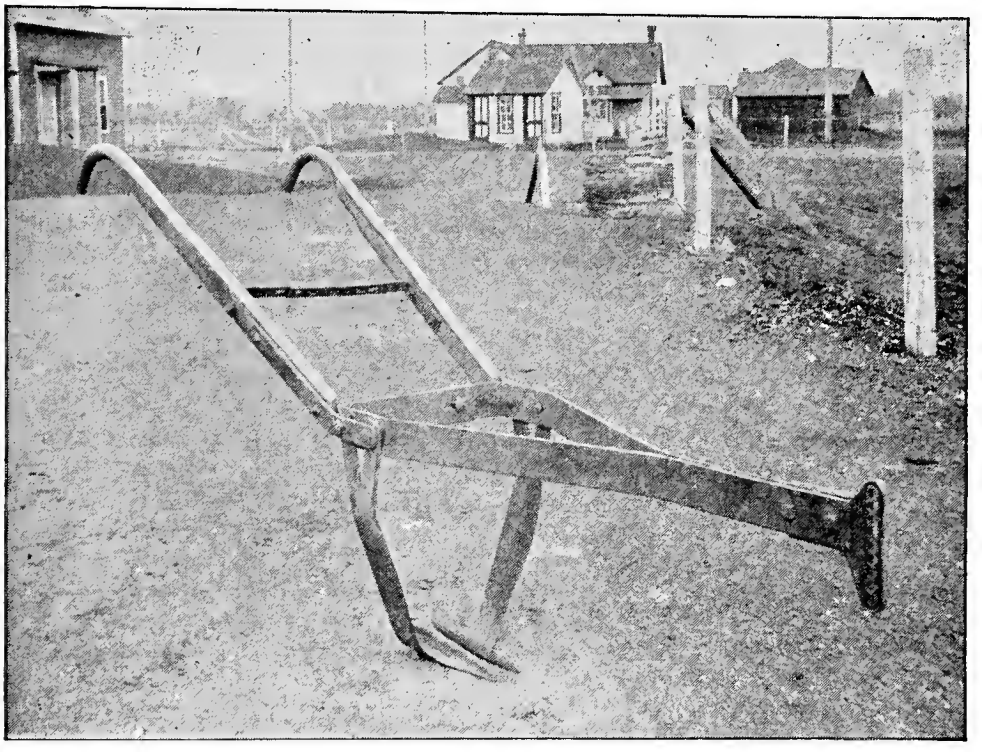
Manager Cutler writes: "We have discovered since then, that frost is something we are not afraid of, providing that our beets are brought here in a perfect state. We have erected since then several platforms, one of which has sides to it, but the top is left entirely open. It is 500 feet long by 34 feet wide, and will hold fully 3000 tons of beets. We also have other platforms with a sluice in the center, but without any sides, and we use a movable railroad track—as fast as the beets are unloaded the track is moved further out, until we have an enormous pile resting on the plank or platform as above described. This system has worked admirably, and the best beets we had stored were those that were left entirely open to the weather. The system of storing in large open piles has proven satisfactory under our conditions. We have stored some 6000 tons of beets in piles on the bare ground, sluices having first been constructed to carry the beets by water to the factory from the piles. When the frost came(and we had the temperature as low as 10 degrees below zero in December, 1896,) it froze over the surface of the stored beets to the depth of two or three beets, but there was enough vegetable heat generated in the large pile to keep the beets in good condition and we have never yet lost a beet from frost. We are more afraid of the sun's rays than we are of frost. There was some loss of sugar in the small outside layer of beets that was frosted, but it was not enough to be of much importance, and the loss is infinitesimal compared with the expense of storing in sheds."

The two past seasons are the only ones in which this method of storing in large open piles without protection from the weather has been tried in severe American winters. The author is not yet ready to recommend this method, as a general practice, in the severe cold weather and alternating freezing and thawing of a northern winter in the middle or eastern states. It should be carefully experimented with under the conditions in each locality.

This plan is not feasible on the farm. Even in Utah, the factory authorities have preferred that the farmers store their late beets in the field according to the system much in vogue in Europe. When this is done, the factory pays the farmer 25 to 35c per ton for thus storing the beets and delivering them when wanted. For this purpose, the Utah plan is to dig a few rows of beets, then to run a tongue scraper down the field, making a shallow trench. As the beets are dug and topped, they are thrown into this trench and covered with leaves, a furrow is plowed down each side to drain off the water, if it should storm, and the leaves are covered with a little dirt to keep them from blowing off the beets. The beets thus stored have generally come in good condition. Some were frozen, but as a rule, the farmers feel that they can store the beets and deliver them at almost any time within two or three months in good condi-

tion. At the same time, experience at the Utah factory is rather against trying to make too long a run, owing to the possibilities of loss in quality as well as other chances.

Siloing in the field has to be more carefully done in Nebraska, and after six years' experience the Norfolk factory recommends this plan, which is a modification of European methods: "In the first place do not harvest your beets until they are ripe, as green beets do not keep as well in silos as ripe ones, and besides should you harvest when too green they might not contain the necessary 12 per cent of sugar with 80 purity. In an average Nebraska season no beets should be siloed before October



THE WALKING BEET PULLER.

This homely device is much used. There are several varieties of it. The tool is quite popular in lieu of a better one.

15th, and if the weather is warm it would be better to wait until the 20th, but in no case should the beets be allowed to remain unharvested (and not siloed) until the ground freezes. Frost-bitten beets will not keep; therefore all beets that you silo must be free from frost and be covered up the same day that they are harvested.

"We would advise making five to seven silos to the acre, placing not less than two tons in each silo. When ready to silo, lift the beets from 40 to 45 rows with a horse harvester. These loosened beets must then be pulled out of the ground by hand and thrown in piles. It is advisable, in case the strip you have lifted contains 45 rows, to make a pile every six rods the length of the strip, and as this section of the 45 rows

is about four rods wide and six rods long, each silo would thus contain the beets from 24 square rods (about one-seventh of one acre). To prevent unnecessary handling it is advisable to first pull out the beets from the middle of the marked 24 square rods, placing them in such shape as to make a vacant place in the center about one rod wide and two rods long, then to pull the balance of the beets, throwing them into a windrow close to and surrounding this vacant spot. When this is finished, top the beets (at the base of the bottom leaves) with one stroke of the knife and throw them in the vacant place, making a pile four feet wide and not over three feet high, the length of the pile depending entirely upon the yield. After all the beets are topped and piled up in proper shape, cover the pile with six inches of dirt, being careful not to have any leaves or straw on the beets or mixed with them, and also to leave wide open a hole one foot in diameter, every five feet on top of the pile (at least two in each pile), for ventilation, as beets will sweat some after siloing.

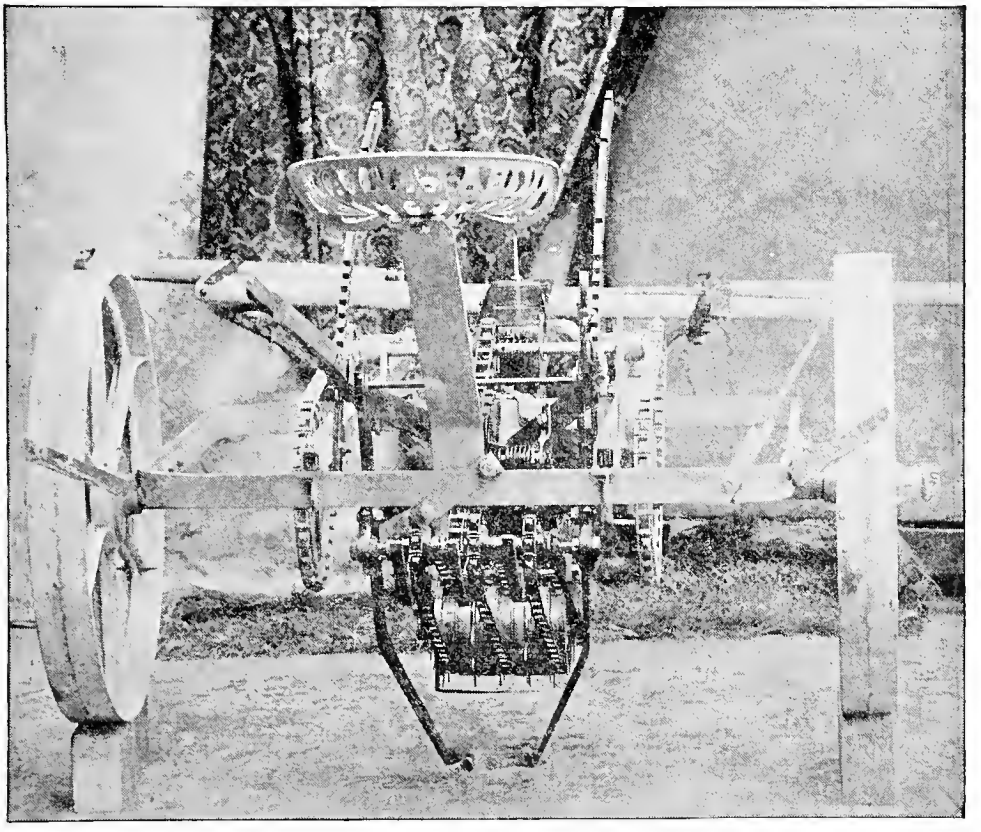
"It is generally advisable not to put much more than six inches of dirt over the beets in October, but to keep them free from frost you should cover the silo before the weather gets cold, say about ten days or two weeks after harvesting, in any case before hard frost sets in, evenly, with five to six inches of loose straw, leaving the ventilation holes uncovered, and place about two inches of dirt on top of the straw to prevent it from blowing away and for the purpose of packing it, as when well packed it will best keep the cold air out of the silo. Thus the covering will finally be composed of six inches of dirt, two inches of packed straw and then two inches more dirt. In an ordinary season such covering should keep your beets from freezing, but should there be exceptionally cold weather you might find it necessary (in case we have not ordered all your beets delivered to the factory by that time) to cover the remaining piles with some long manure. As soon as the covering of silo freezes two inches, shut the ventilation holes with dirt and then keep them shut."

Formerly the farmers were opposed to thus storing the beets, even when paid 30c per ton for so doing, but experience in '95 and '96 convinces them that it is an advantage to the grower also because it gives him a longer time in which to deliver the crop. Concerning the way in which beets keep in these silos, Mr Wietzer of the Norfolk factory writes us:

"Regarding loss in actual sugar of beets kept in silos, we have no actual results, but we have found that beets lose very little or nothing of their saccharine matter within the first two months after siloing. In the old country, it is no secret that beets lose at least 1 to 1½ per cent of saccharine matter during a three months' time in silo, mostly in cases when weather is warm. Experiments made within the last few years have, however, shown that beets raised without fertilizer lose comparatively very little in silos, while beets raised with nitrate of soda show the greatest loss."

Summarizing the most recent European experience on this point Ware says: "It has been demonstrated that the loss of sugar in silos is due to elevation of temperature and too much ventilation, the greatest loss of sugar always corresponding to the most active respiration of the plant. From this the conclusion might be drawn that by keeping air out entirely the problem could be solved; but decomposition of the roots then would certainly follow. When ventilation is too active, considerable loss

of moisture is the consequence; and when this is excessively low the protoplasms die, followed by alteration in the beet cells. The most desirable temperature for silos appears to be 35.6 degrees to 41 degrees F. Avoid all bruises of roots to be kept. is a maxim never to be lost sight of in beets that are to be stored. Twist off the leaves, but do not attempt topping." We may add that Nebraska experience is



BEET HARVESTER WITH TOPPING ARRANGEMENT.

This invention of the Johnson Harvester Co., Batavia, New York, has now been so perfected as to do its work most satisfactorily. It digs and lifts the beets, cuts off the tops and delivers the topped beets at the side of the row ready for factory or silo. This machine is rapidly coming into general use. It will be noticed that the above corrects the reference to this subject on Page 102.

against the hint in the last sentence, as two handlings of the beets cost more than the loss in sugar due to absence of top or necks on beets in silo.

The system of drying beets has been tried on a small scale in California. In that extremely dry and warm climate, the fresh beets when sliced shrink to one-fourth their original weight by loss of water in from three to four weeks' exposure to air and sun. These topped beets contain from 50 to 65 per cent of sugar and can of course be shipped by rail any reasonable distance. The process has only been tried on a small scale and great care had to be exercised to keep the beet chips from fermenting and

spoiling entirely. Whether this can be guarded against sufficiently to make the drying process practical remains to be seen. Should it prove to be feasible, it is possible that such evaporated or desiccated beets might be kept to supply the factories when their original stock of beets was exhausted. In the absence of larger tests of this necessity, it is useless to speculate about it, and the expense of cutting and drying the beets seems to be an almost insurmountable obstacle.

FEEDING AND STORING BEET PULP, TOPS AND MOLASSES.

The pulp from the beets after the sugar is extracted, makes an admirable feed for all stock—horses, cattle, sheep, swine and poultry. Yet its value for this purpose is only beginning to be appreciated in this country, though in Europe the farmers would no more think of allowing beet pulp to go to waste than our farmers would think of curing hay for fuel. At the Utah factory, a feeding company has contracted for all the pulp for a series of years, and have erected adjacent to the factory (so as to save all hauling and handling possible) a complete system of sheds and feeding pens. Two thousand head of cattle are fattened here each season for market. They eat the pulp greedily, consuming from 100 to 125 lbs per head each day, besides about 15 lbs of hay. These cattle command a very good market, the meat being very juicy and tender. The cattle fatten quickly under proper conditions and as the company gets the pomace or pulp for nothing, except the cost of removing it from the factory, the enterprise is a profitable one. The past season over 1000 sheep were fattened here on pulp. At Watsonville, 1700 cattle were fed at the creamery silo, and beets that fall from the wagons there are also used as stock feed, whereas it was formerly necessary to dump the pulp in the ocean to get rid of it. Dairymen pay 15c per ton for having the pulp loaded on cars at factory, and 50c to $1 per ton freight, so that it costs them 75c to $1.15 per ton, besides hauling from local depot to farm; at these terms, they consider it the cheapest and best feed.

The feeding value of beet pomace depends mainly upon the quantities of protein (nitrogenous matter), sugar, starch, fiber and fat it contains, and upon the proportion of these ingredients that are digestible. The California experiment station's analysis of beet pulp may be compared as follows with ensilage of corn fodder and green clover:

TOTAL ELEMENTS OF ANIMAL FOOD IN 100 LBS.

	Beet pulp	Clover silage	Corn silage
Water, lbs,	90.0	72.0	70.6
Ash, lbs,	0.3	2.6	2.6
Protein, lbs,	1.5	4.2	2.7
Fat or oil,	0.4	1.2	0.7
Fiber, lbs,	3.1	8.4	9.7
Sugar, starch, etc,	4.7	11.6	13.7
Total,	100.0	100.0	100.0

AMOUNT OF FOOD DIGESTIBLE ELEMENTS IN 100 LBS

	Beet pulp	Clover silage	Corn silage
Protein, lbs, 2c,	1.3	2.0	1.4
Fat or oil, lbs, 2c,	0.4	1.0	0.6
Fiber, lbs, 1c,	2.5	4.4	6.5
Sugar, starch, etc, 1c,	4.2	9.2	5.6
Feeding value per ton*,	$2.02	$3.92	$3.22

*Based on 2c per lb for digestible protein and fat and 1c for the other nutrients, on which basis the theoretical feeding value of wheat grain figures $17.50 per ton, corn meal $17, potatoes $3, beets 74c, mangels $1.52, turnips $2.75, rutabagas $ 2 and carrots $1.82 per ton.

The protein contains 16 % of actual nitrogen, and the ash is rich in potash and phosphoric acid, as also lime and magnesia. These ingredients are got back in the solid and liquid manure of the stock that consumes the pulp, so that it has an important manurial value. Indeed, in this way, one can return to the soil much that the crop took from it.

It appears that beet pomace that is nine-tenths water is yet worth for stock feed fully half as much as corn silage only 70 per cent water. If the water was dried out

of the pulp so it contains only as much as the corn silage, it would be of about equal feeding value, pound for pound. But cattle eat only 30 to 50 lbs daily per head of silage, whereas they will consume fully twice as many pounds of beet pulp, and thus get much more actual nutriment out of the pomace than they do from silage, as both are commonly fed.

For milch cows beet pulp is excellent, though it should not be fed to excess. Careful tests at the Iowa experiment station show that the sugar beet is very palatable and contains no volatile acid injurious to butter. But whether milk is sold or butter made, we would not advise feeding beet pomace alone any more than silage

RECEIVING BEETS AT ALVARADO.

Showing outside of sheds and pile containing several thonsand tons of beets. Observe the long line of teams ready to discharge their loads of beets.

alone; feed also hay or some dry fodder, with cottonseed or linseed meal, pea meal, or bran. Always begin feeding the pulp to milch cows in small quantities, say 5 or 10 lbs at a meal, gradually increasing as the cows get used to it.

Another advantage of beet pulp as feed is that it can be kept for months without loss of quality by storing in silos. Says Prof Jaffa of the California experiment station: "Sugar-beet pulp is one of the best adaptable materials for silage that the feeder can procure. One of the difficulties encountered in siloing is the exclusion of air from the mass during the curing process. With corn, clover or any of the fodders used for this purpose, much trouble is at times experienced in properly firming the different layers as they are placed in the silo, in order to leave no air spaces in the

mass. The reason for this is, that if much air is present, fermentation will be carried on to such an extent as to spoil a considerable portion of the food. In the case of beet pulp, we do not have to contend with any of the inconveniences just noted. The pulp as it comes from the diffuser in the sugar factory is in the best possible condition for siloing. It is wet, the pieces are exceedingly small and the mass is quite homogeneous. Hence, when placed in the silo it packs itself and fills up every available space, without any intervention on the part of the fillers—a behavior that is very different from that of any other food. For this feedstuff, then, a shallow rectangular or square silo would answer the purpose equally as well as a deep, round one—the style found to yield the best results when corn or clover is siloed. The deeper the silo the greater the pressure, and, therefore, the less air remaining in the silo; the circular shape is adopted so as to do away with corners. It is thus obvious that the expense attending the construction of the silo for beet pulp would be much less than where other fodders are used. In regard to the covering of the material while siloing, the beet pulp has the advantage over corn and clover in that it covers itself, forming a seal, which thoroughly excludes the air. Another point which must not be lost sight of is, that when the beet pulp silage is fed, the portions can be removed much easier and with more facility than is the case where we are dealing with corn, etc. Wherever beet pulp silage has been tried it has met with the best of success, as the animals greatly relish it."

The beet tops and waste beets comprise a considerable tonnage where several acres of beets are raised. This material is also excellent for all stocks, imparting a rare flavor and color to beef or pork, beside making rapid gains in live weight. Feeders about Watsonville are especially enthusiastic over the feeding value of this beet top waste for hogs as well as cattle and milch cows. Similar reports come from Utah and Nebraska, thus fully confirming European experience. These tops will not keep so long as the pulp will, and the sooner they are consumed the better. The tops (leaves), with the neck or upper part of beet that is cut off, constitute about 15 or 20 per cent at least of the gross weight of the crop, so that a yield of 15 gross tons per acre would give about twelve tons of dressed beets and three tons of tops. Many European feeders consider this fodder worth as much as the best hay, pound for pound.

Mr Ware says in a recent issue of *The Sugar Beet*, speaking of Germany: "A factory working 40,000 tons of beets per campaign has 22,000 tons of residuum pulp which, when dried, weighs 2750 tons, the cost of drying being $5 per ton, or a total of $13,750. The product found a ready sale for $17,200, leaving a profit of $3450. Owing to the low market price of molasses, this residuum was mixed with the cossettes during their drying. One hundred pounds of fresh cossettes can absorb 6 lbs of molasses, the product after drying weighing only 15 to 18 lbs. The money value of beet tops and leaves has been determined by analyzing them, and allowing that carbohydrates have a recognized market value. According to all calculations made they should not be sold for less than $1.60 per ton when considered collectively."

The molasses residue from beet-sugar factories has not been much fed in this country. In Europe, however, it has been generally used for this purpose, about one-fourth of the product of many German factories being fed. The great difficulty has

BEET STORAGE SHEDS AT THE UTAH SUGAR COMPANY'S FACTORY.—SEE PAGE 104.

been to find a proper fodder with which to mix the molasses in order to counteract the purging effect which molasses alone (or in conjunction with some other feeding stuffs) exercises on cattle when fed with it, even in small quantities. The latter difficulty has apparently been met by mixing the molasses with a dust or mull obtained from the moss turf that grows on peat. This moss turf is obtained by being torn up or teased out by a machine for making moss litter called a "Wolf." It is taken from the upper strata of high-lying peat moors, and consists largely of the dried but non-decomposed fiber of the plants *Sphagnum cuspidatum* and *Eriophorum latifolium*. The acids contained in this moss turf seem to neutralize the salts in the molasses and render them harmless, thus counteracting the severe purging caused by molasses alone. It is not claimed that this peat stuff itself has any direct feeding value, its usefulness being confined to neutralizing the laxity of the molasses. About 35 lbs of this stuff is used with 65 lbs of molasses, though the proportions vary, and there are several patent processes. The stuff has to be mixed with the molasses while hot. It is being largely fed in Germany, where great claims are made for it, though some feeders dispute these assertions. It is claimed to be much cheaper than the best fat-producing foods, keeps the animal in health, is a good substitute for bran, gives a glossy appearance to the skin, improves quality and quantity of milk, increases weight and improves flavor of meat and can be stored an unlimited time.

The average American farmer will not use any such material. He can, however, mix molasses with cut straw or hay. German experience indicates that the use of molasses in this way increases the amount of actual food elements in the fodder that are digested. The straw is cut into short chaff and the molasses poured over it, which is first thinned a little with water. To every 100 lbs of chaff, add 20 lbs of molasses. Feed with 15 lbs of cottonseed meal or linseed meal or a larger quantity of wheat bran. After cows get used to it they will consume daily 20 lbs per head of this straw chaff with a relish, besides uncut straw and other coarse stuff. The results are most satisfactory. This feed has been found to be most excellent for sheep, hogs, cattle and even horses, but with all stock the feeding with molasses should begin with very small doses. Increase the molasses ration very gradually.

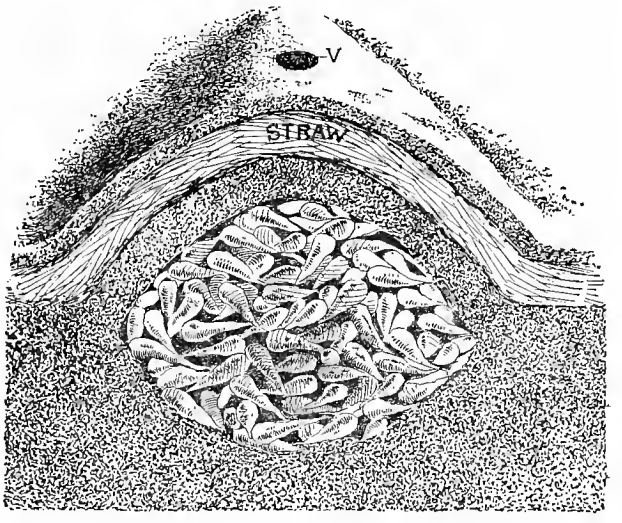
Mr R. M. Allen, who, as manager of the Standard Feeding Co, Nebraska, speaks from long experience in the feeding of beets, necks and tops, says: "I regard it as probable that the profit derived from feeding the waste products of the factory and those parts of the beet left in the field will be almost as great as the profit from the manufacture of sugar. Cattle feeding is a branch of the business that I consider almost as important as sugar manufacture."

PESTS OF THE BEET.

Thus far the most serious obstacles to the production of large quantities of rich beets in the United States have been unfavorable climatic conditions, too much or too little rain or drouth, early frosts, too little sunshine with unseasonable weather during the growing and harvesting period. What can be done to mitigate these natural conditions has been considered in the previous pages. Thus far the crop has not suffered materially from blights or other fungus pests. Beets are sometimes hollow in the center and in that case lack both weight and quality, but this trouble mainly

occurs only in soil deficient in plant food. Improper germination can be avoided by the use of proper seed and the methods of planting already described.

Insect pests have thus far not proved extremely destructive. The garden webworm (*Eurycreon rantalis*) has been perhaps the worst pest. The worm is not quite an inch long, pale or dark yellow, marked with distinctly jet black spots. It feeds on a great many plants, and has several natural enemies. The worm spins for itself a delicate silk cocoon in the debris on the ground at the top of the beet and transforms to the chrysalis stage, in which it remains from one to two weeks. The young worms devour only the surface and substance of the leaf on the side where they are, leaving the veins and opposite epidermis untouched, producing a skeleton leaf. Where the tops are not intended to be fed to stock, Mr Lawrence Bruner, entomologist Nebraska station (Bulletin 16) recommends spraying with a solution of one pound of London purple or Paris green in 200 gallons of water, applied with the modern spraying apparatus, by which the poison is distributed in a very fine mist.



NEBRASKA SILO FOR BEETS.

Cross section. The pile of beets is about 4 feet wide and 3 feet high covered with six inches of soil. Before severe weather sets in, cover with six inches of straw, and then two inches of soil. V—Ventilating holes, one foot in diameter, every 5 feet. See Pages 105-107.

The pale flea beetle (*Systena blanda*), varying from black to nearly yellowish white, gnaws the leaves full of holes upon either side, causing a blister-like appearance, like leaf spot or leaf blight. Spraying with kerosene emulsion drove it away and the arsenical spray effectually removed it. Other flea beetles and blister beetles are sometimes destructive and if necessary can be destroyed as just described. A variety of bugs and a few leaf hoppers are sometimes destructive, the most practical remedy for them being to destroy their natural food plant.

The various cutworms sometimes do much damage by eating off the small beet plants in May and June, in Nebraska. All of these cutworms have parasites that usually keep them from breeding very rapidly, except when some unusually favorable conditions of soil or climate occur. The very best remedy that has thus far been suggested and tried against cutworms is the use of poisoned grasses, cabbage leaves, or clover. This is done by taking these substances and tying them into loose bunches and then sprinkling them with a solution of Paris green or London purple, say a tablespoonful to a bucket of water. Then in the evening scatter these poisoned baits over the field between the rows of beets, cabbage, etc. The worms will be attracted

to them, eat and die. These baits should be renewed several times at intervals of two to four days, according to the state of the weather and the abundance of the worms.

BEET SEED PRODUCTION IN THE UNITED STATES.

At least twenty pounds of seed per acre are required for planting sugar beets. At 12 to 20 cents per lb, this represents an investment of $2 to $4 per acre for seed alone. When from 3000 to 20,000 acres of land are planted to beets for each factory, according to its size, it will be seen that this beet-seed question is a most important one. Up to the present time the bulk of the beet seed used in America has been imported from Germany and France.

Experiments at the department of agriculture's sugar beet station at Schuyler, Neb, with later work by H. H. Nicholson at the Nebraska state experiment station, and the experience of our western beet growers, warrant the conclusion that America can produce its own beet seed. The Utah Sugar Co has 57 tons of mother beets laid by for planting for seed purposes early this spring, a sample of this lot being illustrated on Page 32. They are packed in dry sand and kept at a low temperature to prevent sprouting. These people are now raising quite a large amount of their own seed, have met with great success, and expect by 1898 to cease importing beet seed into Utah. Of course it is very necessary for those who are experimenting in raising beet seed to try small quantities of every variety that comes to their notice. Nicholson truly says that "We cannot build up a great sugar industry, stable and independent, until we have all its absolute requirements in and on our own home soil. We must be free from all possible danger of having our seed supply tampered with, and we must develop varieties of beets adapted to our soil and climatic conditions." Prof Nicholson considered this matter quite fully in his address to the Nebraska beet sugar association, November, '97, from which we quote the following:

The serious difficulty and the great danger—danger to the industry as a whole—in attempting to grow and use our own seed, lies in the lack of proper, I may be pardoned for saying the lack of scientific, selection of parent beets. In this question, of the selection of mothers, is the key to the whole situation. It is a purely scientific question—a question that has been reduced to an exact science by the great breeders and seed growers of France and Germany. If we would not meet disaster, we should sit at their feet and patiently learn the details of procedure.

If, for example, we select this year our best beets—those that will average 16 per cent in sugar—for seed, we will undoubtedly obtain very satisfactory results when this seed is planted. By continuing this process year after year we will soon have difficulty in finding 16 per cent beets—the average sugar content and purity will begin to drop, in accordance with a natural law that all animal and plant life, especially those cases where special features have been artificially developed, tend to return to lower forms.

To keep our beets up to a high grade, then, we must keep introducing props and supports in the way of careful selection in regard to specific points. This introduces into seed growing the elements of science and of expense and lifts the business into the position of a specialty, to be followed only by those content to make it a lifework.

It is a question, perhaps, whether there is yet a sufficient demand for seed in this country to justify the specialist or the capitalist, or both, to enter upon the profession

UTAH BEET SUGAR FACTORY AT LEHI,

Entirely equipped with American made machinery not a single part of the outfit being imported.

of breeding beets for seed, as that is what it amounts to. Naturally, the business of producing the seed begins under and is fostered by the factory management. It is greatly to the credit of the American manufacturers that they have thus early taken the initial steps. But, as has been indicated, the attendant expense, the necessity for special knowledge, and the extreme care necessary at every step, soon throws the business into the hands of specialists.

As has been intimated, the problem presents two important phases, first to produce seed of a very high grade, and, second, to maintain this grade against a constant tendency to retrogression. The solution of these questions has demanded not only the practical experience and skill of seed men, but all the resources of scientific investigation. For these reasons there has grown up in the sugar-beet-producing regions of Europe a class of professional beet-seed growers. Some of these, as Dippe Brothers, Knauer and Schreiber, in Germany; and Vilmorin, Desprez, and Legras, in France, have made reputations world-wide and have amassed fortunes in the business. Their methods are based on strictly scientific principles. Details of procedure vary according as this or that feature is made more prominent. In no case do these, or other reputable growers, allow seed to go on the market until it has reached a certain standard of excellence through several years of upbreeding.

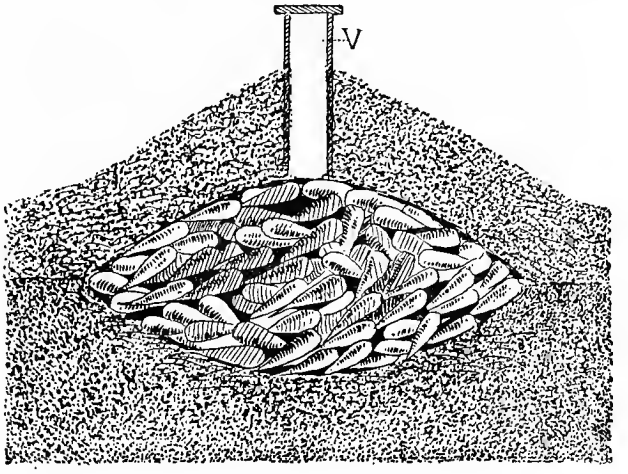
As an example of the extreme care necessary to maintain seed at a high grade, I will briefly outline the ordinary practice of the Dippe Brothers, on their extensive beet farms at Quedlinburg, Prussia. Assuming, for the start, seed of the highest attainable quality. This is planted in the spring in the usual manner and the crop cared for in all respects as a good beet farmer would handle a crop for the factory. In the fall, at the time of harvest, the beets are carefully examined as to their physical characteristics of form, color, size, shape, condition of leaves, and method of growth. Those coming up to a standard previously fixed upon are reserved for seed, while all others go to the factory. This selection usually reserves from one-sixth to one-eighth of the crop as mother beets for the next season. In the early spring of the second year, these mother beets are taken from the silo and subjected to a chemical analysis, for the purpose of securing, for planting, only those of high sugar content and purity.

The analytical process, in brief, consists in taking a small sample from each individual beet in such a manner as to fairly represent the whole beet—this does not in any way injure the root for planting. The juice is then expressed from the sample and polarized. In this way, all of the beets reserved the previous fall are divided into three classes, viz: First, those that fall below a certain minimum per cent of sugar, say 16 per cent, these go to the feed stable; second, those that in sugar content run retween 16 per cent and 18 per cent will be planted as seed-producing or mother beets; third, those that run above 18 per cent in sugar will be planted for seed to keep up the stock.

For convenience, we will call these Classes I, II and III, and confine our attention to Class II. When this chemical selection has finally been made, the beets in Class II are planted. In the autumn the seed stalks are cut, the seed thrashed out, cleaned, and put away for the winter. In the following spring—the third from the start—this seed is planted, but in a manner a little different from the ordinary, inas-

much as the rows are closer together and the beets are thinned to a distance of from three to four inches, the object being to produce a very small and rich beet. The usual summer care is given, and in the autumn these very small beets are harvested; another selection on the basis of their physical characteristics is made, and those retained are carefully stored for the winter. In the spring of the fourth year these small and very rich beets are planted for seed production. According to this method, seed to be offered for sale comes on the market in time to be planted during the fifth year after the first steps in its production were taken. This plan, or one similar, is adopted by all successful seed-growing specialists in the old country. Of course, after the first lot is ready for market, each succeeding season furnishes a crop. The only long delay comes in starting.

The questions of expenses and profits can hardly be touched upon in this paper. During the four apparently unproductive years, while he is maturing his first crop of seed, the seed grower is marketing at the factory six-sevenths of his beet crop. With the harvest of the first crop of seed, and thereafter, he will have to sell both a crop of beets and a seed crop.



CROSS SECTION WISCONSIN SILO.

See Page 115 for general view of these silos. The pile of beets is about 6 feet wide and 2½ to 3 feet high, covered with 18 inches of soil, with a (V) ventilating tile every 6 feet that can be closed after the beets have sweated.

Attempts to reduce such propositions to a basis of figures are always hazardous. The main features, in this case, are clear enough that I will venture on some approximations as to the amount of land required and the current operations and expenses during the four years that the first crop is being prepared for market.

Assuming that 80 tons of seed are needed to supply the present demand in this state, and that we are to attempt to supply this with a well-bred native seed, I will follow, in the main, the plan of the German seed growers. We will start the first year with ten acres planted with the best seed attainable. Assuming an average yield of ten tons per acre, we will harvest 100 tons of beets. Making our selection for mother beets will remove from sale about one-seventh, or some fourteen tons. We will have for market, then, 86 tons of beets.

The second year will see the first year's operations repeated in every detail. In addition, we have to make the chemical selection of mother beets for planting, from the 14 tons reserved the previous autumn, and the planting and caring for, say, one acre of seed beets. Assuming now 28,000 beets to be analyzed and selected; two chemists, with proper appliances and assistants, can make 4000 tests per day, or this selecting can be made in seven days at a cost not to exceed $500, including everything

thing except the laboratory and its permanent equipment. In this selection we will retain one-seventh of the beets, giving us 4000 roots, enough to plant one acre—the remaining six-sevenths go for cattle food. We have in operation, then, land as follows: Ten acres sown with seed and one acre planted with mothers.

In the fall the beet crop is harvested, selections made as before for mother beets, and the remainder sent to the factory. Seed is harvested, cleaned, selected, and stored for the next year's use. The books for this season would show a small excess of expenditure over income.

The third year, all operations of the second year are repeated in detail. In addition ten acres of choice land will be sown with seed selected from the previous year's crop, with the object of producing small and very rich beets. In the fall we will harvest a crop of beets for the factory and to furnish mothers for the next year; a crop of seed for further selection, and a crop of small beets of this year's growing. Land in use this year: ten acres sown with original seed; ten acres sown with our own seed of the previous year; one acre planted with mother beets. The books of this year will also show an excess of expenditures over income.

Fourth year; all of the work of the third year is repeated. In addition to this, we plant 100 acres with choice roots from the small and very rich beets grown the previous year. This fall we will harvest beets for the factory and for mothers; seed for further selection; small, rich beets for final seed production, and from 80 to 100 tons of seed ready for the market. Assuming 80 tons of seed, and a price of 15 cents per pound, the seed product of the fourth year would be worth $24,000.

If care has been observed at every step in breeding, this seed ought to be worth, by reason of the higher return it will yield both to the grower and manufacturer, at least five cents per pound more than foreign-grown seed. Each succeeding year now of operation, on the basis and on the scale of these preliminary years, will yield for market from 80 to 100 tons of seed, worth from $24,000 to $40,000.

To actually produce the seed requires, then, the use of not more than 150 acres of land at one time. A proper rotation of crops would demand, for seed growing on the scale thus briefly and imperfectly outlined, not less than 640 acres.

Of course, there will be many difficulties to be met and overcome. In this state, one of these will be the prevalence of winds at certain seasons of the year. It is possible that this trouble may be met by planting rows of corn at intervals among our seed beets, to act as wind breaks. Certain it is that we shall find some way to meet that and similar difficulties.

European beet growers and manufacturers have established careful rules to secure the best quality of seed. They require that the seed must be from the last crop. It must be of such quality that 100 large seeds must furnish 150 sprouts, and 100 small seeds at least 130 sprouts, these should show within 14 days from the beginning of the test. Not more than 20 per cent of lifeless seed will be admitted. Moisture in the seed should never be more than 15 per cent of the total weight, because more of it causes mold, which injures germinating power. There must be about 45 seeds per gram, or about 22,500 per pound for large seed.

CHAPTER IV.

COMMERCIAL ASPECTS OF THE BEET SUGAR INDUSTRY.

COST AND PROFITS OF BEET CULTURE.

Experience affords widely varying data as to the expense of producing beets and the profits of the crop. In unfavorable seasons, or when growers have not learned how to raise the crop most economically, expenses may be comparatively high and the yield inferior in quality and quantity, thus making the cost per ton very high. Mr Leavitt, an extensive Nebraska beet grower, informs us that his first crop cost him $44 per acre to "lay by" until ready to harvest, to which had to be added expenses of digging and delivering to factory, so that even at $5 per ton they yielded but little if any profit on the crop ordinarily obtained. But his sixth successive crop (1896) cost only $11 per acre to lay by, and at $4 per ton the crop yielded a substantial profit. This is probably a greater saving than will occur with the average beet grower, but it illustrates in a striking way the possibilities of economy in beet production. The value of land, expressed either in rent or interest and taxes, and the amount and cost of fertilizers employed, are also varying factors, as well as yield.

We caution farmers and capitalists against basing estimates upon extraordinary yields per acre, either in quantity or quality. While it may be that the crop may occasionally go as high as 20 or 25 tons per acre, and return an apparent profit of $40 to $60 per acre, that is no more a fair criterion to go by than to judge of the possibilities of corn culture on the basis of a yield of 135 bushels of crib-cured shelled corn per acre (which was grown in the *American Agriculturist's* contest in Marlboro county, South Carolina, in 1889), when a fair average yield of corn is 25 bushels per acre. Here is the place for farmers to start right, and not to deceive themselves with fancy figures. Far better for all concerned to go into this industry on so conservative a basis that their estimates are excelled in actual results, than to start with exaggerated ideas, failing to realize which causes discouragement and disaster.

On this point Mr Weitzer, field manager for the Norfolk factory reports: "Our six years' experience in Nebraska has shown us that seven tons of beets per acre pay for all the team work (at 50 cents per hour), all the hand labor (at 7½ to 15 cents per hour) performed on the field, also for seed, rent of land and machinery and freight; all of the yield above this tonnage being clear profit. Ten tons may be regarded as an average crop per acre, although much higher yields are made. A good farmer, who takes the right care of the crop and selects proper land, should, in an average season, raise not less than twelve tons per acre. Our old beet growers even claim to be able to raise, in a good season, by using richly manured bottom land, 25 to 30 tons per acre, which yield has already been obtained by several parties."

Valuable information upon this point is furnished by a tabulated statement of the experiences in 1896 of 49 growers of 1442 acres of beets for the Norfolk and Grand

Island factories, as collected by the Nebraska beet sugar association, and published in its Hastings proceedings for 1896. The area harvested by each grower was from 8 to 80 acres, averaging about 18 acres to each farmer, exclusive of one who raised 455 acres and another with 174 acres. At the time of the Hastings convention, Nov 17, about half these beets had been delivered to the factory, the balance being ensiled for delivery later. The reported yield was 17,924 tons from the 1442 acres, or an average of 12½ tons per acre, ranging from 8 to 20 tons per acre—the larger yields upon the smaller tracts. The proceeds for beets sold were estimated at $90,016, or $62.40 per acre. This was based on $5 per ton for beets, of which $4 was paid by the factory and $1 was claimed under the state bounty offer. If the latter is not paid, the gross proceeds are about $12.50 per acre less, averaging just about an even $50 per acre. The expenses reported average $36.88 per acre, leaving average net profits of $13 per acre, as follows:

	Per acre	For 1442 acres
Cost of seed,	$3.00	$4,363
Rent of land,	3.96	5,708
Value of all labor,	25.56	36,976
Other expenses,	4.36	6,302
Total expenses,	$36.88	$53,349
Profits,	$13.12	$18,751
Total receipts at $4 per ton,	$50.00	$72,100

This shows an average cost of just about $3 per ton of beets delivered to the factory, including wagon haul and railroad freight, on a crop of 12½ tons per acre, over nearly 1500 acres in various sections of Nebraska, and representing all sorts of culture and soil. Closer analysis of the returns shows that the larger yields of the more careful cultivators were produced at a cost of $2 to $2.50, and in one or two instances even less. It is to be regretted that these figures are based on estimates at close of season, not upon actual accounts, though our inquiries indicate that the items of cost are above the actual, if anything.

It is to be remembered, however, that the foregoing figures are for an exceptionally favorable season. They are based upon the experiences of the better growers also—intelligent men, experts, of several years' experience; the other kind, who most need its help, don't attend the beet growers' meetings. Even the best men could not make so good a showing for the unfavorable year of 1895. Yet here are the figures for the '95 crop upon 40 acres grown by Pettinger Brothers at Albion, Boone county, Neb:

EXPENSES.		PROCEEDS.	
Seed for 40 acres,	$107.00	577⅞ tons dressed beets over 12 % sugar 80 purity at $5 per ton of 2000 lbs,	$2888.33
Hand work at $12 per acre,	480.00		
Extra labor,	150.00		
Topping beets at $3 per acre,	120.00	46⅛ tons inferior at $2.50,	115.83
Freight at 80c per ton,	538.40	Received for siloing 258 tons at 30c,	77.34
Total,	$1399.40	Total,	$3081.50

Deducting the expenses reported ($1399.40) from the gross proceeds ($3081.50), there is left $1682.10 as the net return for the team work, use of land, pay for superintendence and profit. This is $42 per acre for these items on a crop that dressed nearly 15 tons per acre, when sold at $5. This price includes the $1 state bounty. Deducting that, or $15 per acre, leaves $27. A detailed statement of Pettinger Brothers' experience is printed on Pages 126-127.

Mr R. M. Allen, president of the Nebraska beet sugar growers' association and of the American sugar growers' society, says that the result of his six years' experience is that "The cost of growing beets to farmers in Nebraska is from a minimum of

$2 per ton delivered at the factory, up to a figure where it becomes unprofitable to raise them even at $5 per ton. The average cost to farmers probably ranges from $2.50 to $3.50, with an average yield of from 10 to 12 tons. These figures do not include rent, fertilizers, or profit. The first two large areas of beets raised under my own charge cost $3.60 and $3.80 per ton, respectively (actual book accounts), the first being a year of very high cost and the second a drouth year of decreased yield." Mr Allen submits detailed statements of these (1893-4) crops as printed below, but we understand his 1896 crop was grown at very much less expense.

RESULT OF CROP.

	1893	1894
Number of fields grown,	21	23
Number of acres grown,	500	569
Lowest yield per acre,	9 tons	6.6 tons
Highest " " "	30 "	19.5 "
Average " " "	17½ "	10 net tons
Net delivered at factory,	15 "	10 " "
Gross tonnage,	8709	6165
Net tonnage shipped,	7514	5803
Shrinkage,	13.43 %	5.8 %
Total cars shipped,	436	346
Average sugar content,	11.94 %	14.95 %
Highest " "	15.50 %	18 %
Average purity,	77 %	79 %
Highest "	86 %	86 %

EXPENSES PER ACRE.

	1893	1894
Cleaning off corn stalks,	$3.50	*a*$2.00
Plowing,	2.20	2.01
Harrowing,	1.30	.50
Rolling,	.50	.31
Seeding,	.40	.30
First hoeing,	4.00	1.44
Thinning,	13.00	5.84
Two times hoeing after thinning,	12.00	*b*12.97
Cultivating,	2.15	1.82
Seed,	2.25	2.00
Cost of laying by,	41.30	30.16
Harvesting,	6.00	*c*6.00
Hauling and loading,	6.75	2.13
Total cost of crop per acre,	$54.05	$38.29
Cost of beets per net ton,	$3.60	$3.82

a Manuring. *b* Second hoeing $5.25, 3d $4.81, 4th $2.91 per acre. *c* Plowing out cost $2 per acre, pulling and topping $4.

In Utan, the average cost of cultivating, harvesting and delivering a crop of 12 tons of beets per acre to the factory, not to exceed four miles distant, is from $28 to $35, and at $4 per ton this leaves a net income of $13 to $20 per acre, besides the $28 or $35 worth of labor furnished by the farmer and his family and teams, for which he gets paid in cash. Going into more detail, the Utah Sugar company says that, if everything is hired or if the labor is charged for at the price it would cost to hire it, the expense of cultivating beets in Utah would be about as follows: "Preparing soil for seed, $3.50 per acre; that is, plowing, harrowing, leveling, rolling and the necessary work to make a proper seed bed. Twenty pounds of seed per acre will cost $3, and planting with the seed drill 50c per acre. Thinning costs about $5 per acre, but this item will be less after a few years' experience. The second hoeing is as necessary as the thinning, and costs $2 per acre. We irrigate two to five times, as the case may be, averaging three times; at 40c per acre for each irrigation, this would cost $1.20, though it may cost more the first season. We cultivate six times, three before irrigation and three after, at a total cost of $14.40. Plowing out the beets in the fall will cost $1 per acre. We pay 50c per ton for pulling and topping the beets, which, for an average yield of 12 tons, is $6 per acre. This makes a total expense of $30.60, exclusive of use of land and manures, paying highest market prices for all labor."

One of the most extraordinary financial statements ever made by an American beet grower is that submitted by James Bardin, of Monterey Co, Cal. In 1892 he shipped 6082 tons of beets to the Watsonville factory from 225 acres of land, making the phenomenal average of 27 tons of dressed beets per acre. The cost of seed and planting averaged $5.12 per acre, harvesting $7.45 per acre, cultivating and weeding

was done by contract by Chinese at $1.65 per ton, while the freight was 75c per ton. This made a total cost per ton of $2.83, and as the beets were sold at $5 per ton at the factory, it left $2.17 per ton for the use of land and net profit. Adding net gains from stock fed on beet tops, Mr Bardin shows an average return of $59.33 per acre for his own time and use of land, or a total profit of $13,352. Mr Bardin says there is just as much money now in raising beets at $4 per ton as there was then at $5, because freight has been reduced 25c per ton, contracts for taking care of crop, hoeing, thinning, topping and loading into wagons have been reduced 65c per ton, and the crop can be handled 10c per ton cheaper now on account of improved machinery, making a total of $1 reduction to offset the decline of $1 in the price.

Mr Bardin writes us that in 1893 and 1895, he was not directly interested in growing sugar beets. In 1894, he planted 450 acres to this crop, but the land was not in good condition and the yield averaged only 13¼ tons per acre dressed weight. Part of the tract was new land that had not been cleaned but one year, and some had been planted to crops which the beet does not follow well. In 1896, he planted 260 acres, which were all harvested before Oct 1 and averaged between 16 and 17 tons per acre for the whole tract. One of these fields of 80 acres, planted the first week in March, yielded 25 tons of dressed beets per acre. Another field of 100 acres was not all planted until the latter part of April, and owing to the extremely dry season made not more than 8 or 9 tons per acre. If the season had been favorable, he believes the whole tract would have averaged 25 tons and is perfectly satisfied with the crop as a profit earner, when sold at $4 per ton.

Mr Bardin's items for planting the 225 acres first mentioned were: Labor $450, seed $180, use of beet drill $22.50, barley fed to teams when planting $10.50, hay fed (at $8 per ton) $200, wear and tear of tools $150, total $1,152.50 for planting. The detailed account for harvesting shows that the expense was $1677. Caring for the crop was contracted for by Chinese at $1.60 per ton, or a total of $10,166; freight at 75c per ton cost $4561, making the grand total for all expenses $17,556. The receipts being $30,908, left the net profit above stated of $13,352. This is an extraordinary result of an extraordinarily favorable season, which even Mr Bardin himself has not since been able to duplicate. Moreover his land is in beets only one season in three years, and his last crop averaged only about one-third as large a crop as the phenomenal results in '92. Even under the most favorable Californian conditions, therefore, it is safe to discount this result fully one-half and we doubt very much if the majority of California beet growers average $30 per acre per year, for use of land, for their ability in running the business and for net profits over and above all other expenses of every kind and nature.

ACTUAL EXPERIENCE OF FARMERS IN RAISING BEETS ON A LARGE AND SMALL SCALE.

Pettinger Brothers of Albion, Boone Co, Nebraska, writing in September, 1896, said: "Nebraska farmers are only just beginning to know a small part of what there is to learn about farming, and especially sugar beet raising. In Boone county, the first sugar-beet crop was planted in 1884. Our first crop contracted for consisted of ten acres. The soil was prepared and the crop planted the best we could with such instructions as were given by the factory, but the soil was a little sandy, and during

June about half the crop was cut off by drifting sand, or buried out of sight; what was saved yielded about six tons to the acre. While this was a very light crop, we felt encouraged to try again. At first we did our own hoeing and thinning, but have since had German-Russians to do this work; they are by far the best and cheapest labor. The following spring, we contracted to put in 40 acres. The soil is a slightly sandy bottom land, just sandy enough to work nicely, with a good clay subsoil. The field planted in '95 had been a timothy meadow for about 12 years previous to plowing for beets. We plowed six or seven inches deep, following in the fall with a subsoil plow, going to the depth of six inches more, stirring the soil thoroughly to the depth of twelve or thirteen inches and harrowing each day's plowing as it was done. For the seed bed, the field was gone over three or four times with a disk harrow, working the top thoroughly; then we took a railroad iron, put on eight horses and went over the ground until it was perfectly smooth. This smoothing iron is illustrated herewith and I like it better than a harrow, as it packs the soil better and makes a splendid, fine, seed bed, without which it is of but little use to plant beets. Preparation of the soil is the main point; you cannot get the seedbed too good. One great thing is not working the top too fine. In this preparation, most of the work can be done with a disk harrow, as it does not crush all of the small clods, thus preventing blowing and cutting off by the fine dirt and sand that is driven over a field that has been so thoroughly worked. Planting was begun May 1 and finished May 25. A little re-planting was done June 10. A good stand has never failed us if the ground is in perfect shape at the time of planting. Planting is but little trouble, the seed being put in from ½ to ¾ of an inch deep and covered with a moist soil. The Jewell planter was used last year with good success. We never use flat shovels in cultivation, preferring the goose-foot shovels, which we like much the best. Thinning is begun when the plants are two inches high. We bunch thin and clean all of the small weeds out at one time and are particular that this work is well done. Cultivation is kept up every week or ten days as long as we can get through them; in all, about five times.

"SMOOTHER" FOR BEET LAND, MADE OF A RAILROAD RAIL.

This leveler is 28 ft long and bent slightly in the middle so that it will not turn over—a curve of say 2 ft in the length of the iron. The horses are hitched far enough from the ends so that the draft of the teams will make the iron plow level. Hitch the horses so that the curve is to the front as portrayed above. If the curve is to the rear, the iron will dip in the middle and the ends draw up and it will not work satisfactorily.

"In 1895 the mode of work was changed but little from that of the preceding year. We were a little more careful as to details. Pains are taken that all weeds are killed before planting. Plant as soon as the soil is ready. Do not let it lay three or four days after it is ready to plant, as the weeds get just that much of a start. We think if we get our crop started right, future cultivation is easy. During the summer of '95, most of our crop was irrigated the latter part of July or early August. Irrigation is what saved our crop from testing low, as they grew and ripened. When the late rains came in the fall, they did not take on a second growth but retained their ripeness and sugar. Out of 56 carloads shipped to the factory, only four loads went below 12 per cent sugar and 80 per cent purity. Last year we did not irrigate, but I believe it will pay as a rule. Our beets were not as good last year as in '95; the early part of the season was too wet. The ground on which the '95 crop was

raised was put to corn, beets and chicory last year; the corn was a good average crop of 50 bu or more per acre, the beets were as good as the average of the field, and the chicory from this field took first premium at the state fair. I believe that 12 tons can be raised every year if the work is done properly. The beet crop of '95 was heavy and it was impossible for the factory to receive and store what beets they could not work up before they would freeze in the ground or in piles, so they gave the farmer about 30c per ton for siloing a portion of their crop and holding it five or six weeks, thus giving the factory a chance to take those siloed beets later in the season. This same crop furnished a splendid feed of beet tops for milch cows, making the entire feed for our 26 head from Oct 1 to Jan 1. They produced an extra flow of milk and it tested high at the creamery. An acre of beet tops is worth from $3 to $5 as feed for cows and hogs, both of which eat them greedily."

Here are some reports from farmers at Chino, Cal, for the seasons of 1891-4 inclusive: E. M. Day planted 25¾ acres to beets, from which he harvested 409 tons, for which he received $1400. On his home place he had 5¾ acres, the beets from which brought $525, or $91.30 per acre. On another ten acres he harvested 204 tons, which brought him $4.50 per ton. This makes the returns for the ten acres $918, or $91.80 per acre. The $1400 he received for his entire crop was all clear gain, except $40 he paid out for wages and $75 for seed and use of cultivator. Himself and two boys, one 11 and the other 15 years of age, did enough work on their own crop and in exchange with their neighbors to clear all expenses on their own crop except the $115 noted. In other words, Mr Day's summer work on his beet crop has brought him just $1284 in clear cash. Besides this, he has taken care of, cut and harvested ten acres of alfalfa of his own, raised fourteen acres of barley, and did $50 worth of work cutting alfalfa and barley for other people. This will go a long way towards paying all his living expenses for the year, and his beet crop can be counted clear gain. Mr Day says he lived in Nebraska for twenty-five years and in all his farming experience he has never done as well as he has here, or found the product that paid as well as sugar beets.

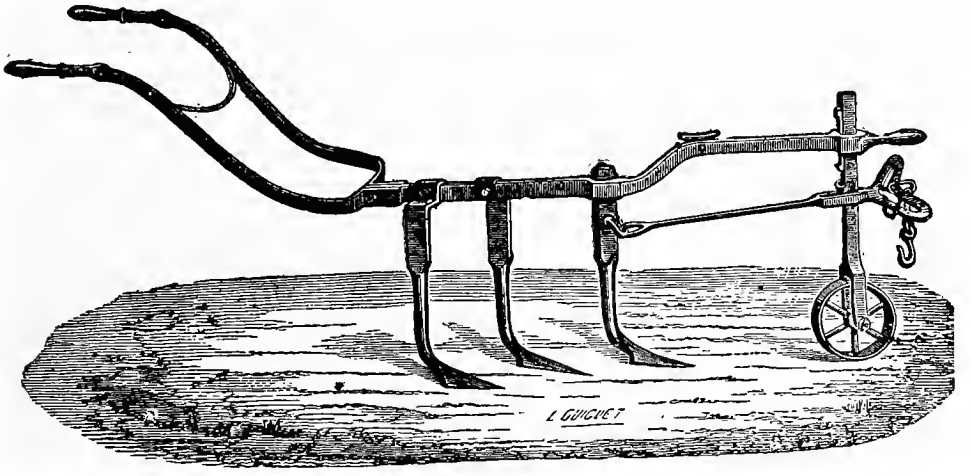
George C. Moore rented 36 acres, which he planted to beets. He did the team work and a large part of the labor upon the crop himself, hiring no more than he could avoid. He is an energetic, painstaking and careful man, and his care has been well rewarded. In making a statement of his expenses on the crop, he included his own labor and that of his teams. His actual expenses in money were therefore much less than the figures given. He sold 649 tons (at $4.25) for $2.758.25; expenses: Plowing $72, preparing ground $27, seed $64, planting $12, thinning $108, cultivating $25.20, hoeing $70, pulling and topping, $374.50, hauling $299.60, factory expenses $52.45, total $1,104.75; rent, 25 per cent, $684.56; grand total, $1,789.31; net profit, $968.94.

Peter Varner harvested from eighteen acres 360 tons of beets, or twenty tons per acre. For these he realized $3.90 per ton, or $1404 for his crop—$78 per acre. Less than three years ago Mr Varner came to Chino with no capital whatever but his energy, his perseverance and his pluck. He has recently purchased $3000 worth of land for a home, and he is paying for it with money realized from beet farming. He

says he is satisfied that there is no other line of farming in California in which he can do as well as growing sugar beets.

N. S. Rice planted sixteen acres, from which he harvested 201 tons net, or about 12¼ tons per acre. At $5.60 per ton, these brought him $816.52, or $51.04 per acre gross. The money he actually paid out in raising and harvesting the crop was as follows: Seed $57, thinning $54, plowing and planting $30, topping $10, total $242. All the rest of the work was done by himself and no account was kept of it. This leaves his returns on the sixteen acres $574.52.

W. C. Rightmier harvested from twenty-seven acres 400 tons, or an average of 15 tons per acre. They analyzed between 13 and 14 per cent sugar, making an average



DELVER FOR WORKING THE SUBSOIL.

Machines of this character are not used in America, but are considered almost indispensable in Europe. The work of the delver begins where the subsoil plow left off, the delver running after it to still more deeply stir the subsoil so that the beets have the least possible resistance to overcome in their descending development. Mr Ware says in *The Sugar Beet* for November, 1896, from which our engraving is taken: "This delving operation is frequently continued even after the roots have attained considerable size, that is, after weeds are little to be dreaded and when the cultivators are no longer necessary." It is easy to see how useful such an implement can become, especially during a long dry spell, when the lower portions of the soil are frequently too hard to admit of a thorough penetration by the shoots and hairy growth of the beet.

price of say $4.10 per ton. This would give Mr Rightmier in the neighborhood of $61.50 per acre from his field. Another field of eight acres gave 172 tons of beets averaging 14½ per cent sugar, 21½ tons per acre at $4.50 per ton, or a return of $96.75 an acre for the field.

HOW THE INDUSTRY EMPLOYS AND PAYS LABOR.

The chief item in raising sugar beets is labor. It constitutes from 60 to 75 per cent of the total expense of beets delivered to the factory, and in some cases even more. Out of average expenses of $36 per acre in Nebraska, over $25 was for labor. Mr James Bardin's 225 acres that produced such a profit in 1892 (see page 121), was sowed to barley the next year, the crop yielding 3500 lbs per acre and at 65c per cental made a net profit of $12.75 per acre—about one-fifth the profit on sugar beets. He paid for labor on this barley crop $360, while the labor on the beet crop on the

same land the year before cost $10,666. Adding $3500 for payroll to labor at factory during the time required to manufacture the crop into sugar, labor got about $15,000 out of this beet crop. In other words, for every dollar paid for labor on barley, there were paid $41 for labor on beets, so that "for every man who gets a job on a grain crop, 41 persons get a job on beets."

Skilled labor is not required for much of the work of pulling and harvesting, while some of the thinning and weeding can be done by boys and girls. The crop thus furnishes an extremely important home market for a grade of labor that otherwise would hardly be employed at all. Indeed, such labor can be worked to better advantage and more cheaply than Chinese contract labor. James Hopkins, Jr., of Watsonville does not believe in paying $1 per ton of beets for Chinese labor, as his crop last year, worked with white boys and girls, cost him only 75c per ton for labor. Of course boys will be boys, and it is necessary to work in the field with them yourself, but under proper supervision boys and girls will work rapidly and well and are to be preferred to the contract system. If 25 or 30 per cent can be saved by employing boys and girls, it amounts to many thousands of dollars each year.

No other crop is so attractive to the laborer of all ages and grades of skill as the sugar beet. It gives employment not only to the farmer, but to every member of his family, pays them spot cash for this labor and yields a fair profit besides. J. W. Johnson made a study of this point in the Nebraska beet fields in '96 and reports in the *State Journal*: "The net profits of the growers, in one case amounting to $1400 on 80 acres, does not alone measure the importance of the industry. Its value to the community consists chiefly in giving employment to all people who want to work, and to that class who are unskilled and can perform only the simplest kind of labor. Anyone who can handle a hoe or pull weeds can earn money all summer in the beet fields. Anyone who can hold a sharp corn knife in one hand and a beet in the other can top beets and earn $1.25 a day. Any man can load beets into a wagon from the field and can shovel them out of the warehouse at the factory. All this labor is available to those who need labor most. There is $25 worth of cheap labor in every crop of beets produced. A large part of this goes into the pockets of poor people who have no ability to make plans for themselves, or to sustain themselves in any other way except by manual labor of the simplest kind."

PRICE OF BEETS.

The price paid for beets is for the net weight of trimmed and washed beets as delivered at the factory. When beets arrive at the factory, an average 50 pounds is taken from each wagon load, thoroughly washed, examined to see if properly topped, and then weighed again, the loss determining the tare. This tare should not be over 5 per cent, if the beets are properly harvested and prepared. Two systems of paying for beets are in vogue, a straight price and a graded price. The beet grower who gets a straight price per ton knows what each ton will bring beyond question, and knows that he can sell all of his beets that come up to the required standard, which is usually 12 per cent sugar of 80 purity. Beets poor in quality are refused or accepted at a much lower price. On the other hand, if paid according to the amount of sugar in the beet, the careful farmer who grows rich beets will get a better price.

The Spreckels factory at Watsonville and his new mill at Salinas pay a straight price, at present $4 per ton, though before the repeal of the McKinley bill it was $5 per ton. We believe the Alvarado factory has also paid a straight price. At Chino, however, the first five-year contract was based on $3.50 per ton for beets containing 12 per cent of sugar and 25c additional for each additional 3 per cent, and under it farmers received an average of $4.50 per ton. In 1896, contracts were based on $3.25 per ton with an additional 25c per ton for each percentage above 12, which has netted the growers nearly $3.78 per ton. To protect their interests, the growers are well organized and choose their own weigher and chemist and also their own tare man, the expense being about 3c per ton.

In Nebraska, at first $4 per ton was offered for 12 per cent beets of 80 purity, the price being advanced 25c for every additional percentage of sugar, up to $7 for beets containing 20 per cent sugar, but it was afterwards found to be more satisfactory to have an average price for all beets above 12 per cent sugar with 80 purity, and this price was fixed at $5 per ton (including the $1 state bounty). If the beets run below this standard, they are accepted at half price. In Utah, the plan was tried of paying different prices for different qualities of beets, but it proved so unsatisfactory to farmers, that one fixed price of $4.25 was established for all beets containing 11 per cent sugar of 80 purity, the price for 1897 being $4, and beets below this standard are not accepted at all. Where the farmer is careful with his growing crop and at harvest sorts out all the large coarse beets, this crop will usually fulfill the contract.

HOW TO GET A SUGAR FACTORY.

The first step to take to get a beet-sugar factory, is to demonstrate that your township, county and district can grow the right kind of beets in profitable quantity. If your farmers have not demonstrated this fact, apply to your state experiment station for particulars about tests that have been made in other parts by the state. Get all the points you can from your experiment station—that's what it is for, to help your farmers and free of cost to them. Then from the instructions given in this book, let every farmer grow half an acre or less of beets. Have samples of all these beets analyzed at your state experiment station* to determine their sugar content and purity. Keep a record of all these crops, the soils and conditions under which they were grown, yield, cost, etc. Repeat these tests a second and third year if necessary, to establish the fact that your locality is adapted to the crop. A small patch of beets on various soils on each farm is better for testing than a few large areas. The beets can be fed with profit to stock, if no factory is available to which they can be shipped. This sort of preliminary work has been done for years in many parts of California and accounts for the firm position of the industry in that state.

Analyses of beets grown under all sorts of conditions and soils will enable any practical beet-sugar man to decide whether such locality can be depended upon to furnish beets in sufficient quantity and quality to operate a factory successfully. There is no doubt in the least of the reliability of the laboratory or analytical work of our sugar chemists. Consequently, we were surprised to have a gentleman who was supposed to know something about the industry advise localities wanting sugar factories to begin by establishing a small distillery. "With a capital of $30,000, such

* See addresses of experiment stations at bottom of next page.

a plant could work 30 tons of beets per day, using all roots furnished. Every gallon of pure alcohol obtained corresponds to a certain per cent of sugar in the beet. Then, after the farmers had learned how to grow beets, the purchase of beet-sugar machinery could follow." This suggestion is not practical at the present time, if indeed, it ever was. In the first place, analyses will determine the sugar content, and secondly, such a distillery would not pay. The tax on alcohol is too high and it requires a very large amount of grain to give to alcohol from beets the necessary life. Besides, the whisky trust would interfere with the sale of such a product. The thing has been tried with molasses from Grand Island at the Columbia distillery in South Omaha. It was found there was no money in it. Mr Thomas R. Cutler, manager of the Utah sugar company, informs us that he has investigated this matter thoroughly in both American and foreign countries, and has concluded that in the United States it would be unprofitable.

The beets and other essentials satisfactorily provided for, the one vital question becomes: Will farmers contract for a series of years to grow 2500 to 10,000 acres of sugar beets for the factory, depending upon its size, at an average of say $4 per ton delivered at factory, with the full benefit that may come from whatever state or national aid may be extended to the industry? The locality that is able to offer the best guarantee of this kind is the one that (other things being equal) will prove most attractive to any who may be seeking investment in sugar factories.

To conduct all this work to the best advantage, a local organization is desirable. For this purpose let all interested unite in forming a local branch of the American

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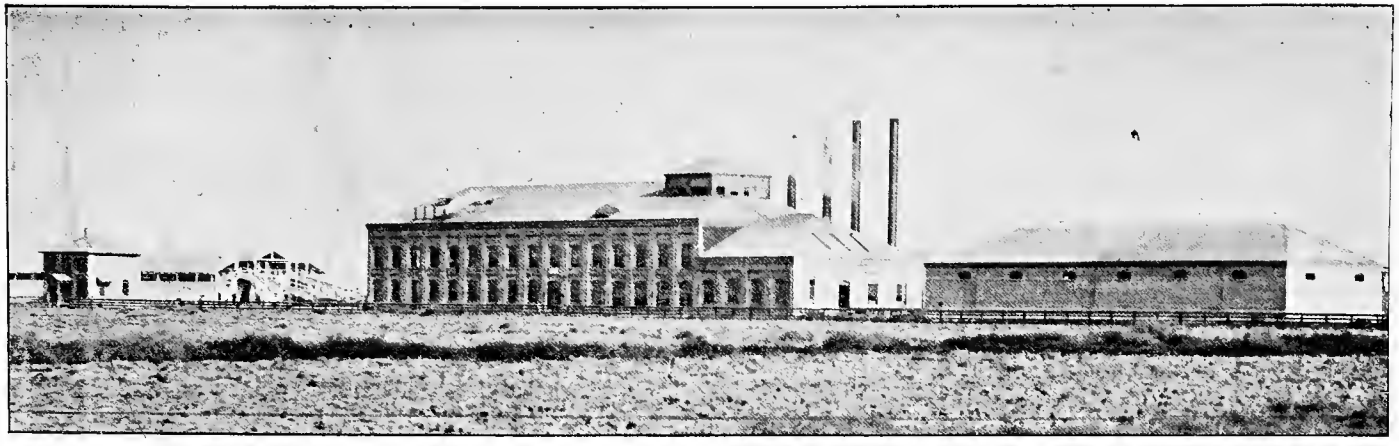
* THE STATE AGRICULTURAL EXPERIMENT STATIONS,

Where located, name and postoffice address of the director or person in charge.

ALABAMA—Auburn: College Station; W. L. Broun. Uniontown: Canebrake Station; H. Benton.
ARIZONA—Tucson: W. S. Devol.
ARKANSAS—Fayetteville; R. L. Bennett.
CALIFORNIA—Berkeley: E. W. Hilgard.
COLORADO—Fort Collins: Alston Ellis.
CONNECTICUT—NewHaven: State station; S. W. Johnson. Storrs: Storrs Station; W. O. Atwater.
DELAWARE—Newark: A. T. Neale.
FLORIDA—Lake City: O. Clute.
GEORGIA—Experiment: R. J. Redding.
IDAHO—Moscow: C. P. Fox.
ILLINOIS—Urbana: E. Davenport.
INDIANA—Lafayette: C. S. Plumb.
IOWA—Ames: James Wilson.
KANSAS—Manhattan: G. T. Fairchild.
KENTUCKY—Lexington: M. A. Scovell.
LOUISIANA—Audubon Park, New Orleans: Sugar Station. Baton Rouge: State Station. Calhoun: North Louisiana Station; W. C. Stubbs
MAINE—Orono: C. D. Woods.
MARYLAND—College Park: R. H. Miller.
MASSACHUSETTS—Amherst: H. H. Goodell.
MICHIGAN—Agricultural College: C. D. Smith.
MINNESOTA—St Anthony Park: W. M. Liggett.
MISSISSIPPI—Agricultural college: S. M. Tracy.
MISSOURI—Columbia: H. J. Waters.
MONTANA—Bozeman: S. M. Emery.
NEBRASKA—Lincoln: G. E. MacLean.
NEVADA—Reno: J. E. Stubbs.
NEW HAMPSHIRE—Durham: C. S. Murkland.
NEW JERSEY—New Brunswick: E. B. Voorhees.
NEW MEXICO—Mesilla Park: C. T. Jordan.
NEW YORK—Geneva: State Station; W. H. Jordan. Ithaca: Cornell University Station; I. P. Roberts.
NORTH CAROLINA—Raleigh: H. B. Battle.
NORTH DAKOTA—Fargo: J. H. Worst.
OHIO—Wooster: C. E. Thorne.
OKLAHOMA—Stillwater: G. E. Morrow.
OREGON—Corvallis: H. B. Miller.
PENNSYLVANIA—State College: H. P. Armsby.
RHODE ISLAND—Kingston: C. O. Flagg.
SOUTH CAROLINA—Clemson College: E. B. Craighead.
SOUTH DAKOTA—Brookings: J. H. Shepard.
TENNESSEE—Knoxville: C. F. Vanderford.
TEXAS—College Station: J. H. Connell.
UTAH—Logan: L. Foster.
VERMONT—Burlington: J. L. Hills.
VIRGINIA—Blacksburg: J. M. McBryde.
WASHINGTON—Pullman: E. A. Bryan.
WEST VIRGINIA—Morgantown: J. A. Myers.
WISCONSIN—Madison: W. A. Henry.
WYOMING—Laramie: F. P. Graves.



The Plant Viewed from the Southwest.

TWO VIEWS OF THE LOS ALAMITOS SUGAR WORKS.

At the new town of Los Alamitos, not far from Los Angeles, southern California. This enterprise is owned by W. A. Clark of Montana and by J. Ross Clark, the manager.

Sugar Growers' Society. Then you will be leagued with similar efforts all over the country, provided the society is thus supported, and in many ways can benefit by such connection.

As to financiering a sugar factory enterprise after it is demonstrated that your community can furnish the necessary beets, there are numerous methods. On general principles, we do not favor paying a bonus outright to secure an industry, although this is a very common method. If outside capital is necessary, it can usually be attracted by the offer of the community that wants a factory to furnish a part of the money. Suppose, for instance, it is desired to erect a plant which, with working capital and all appurtenances, requires an investment of $500,000. Instead of offering a bonus of lands or money, let the community offer to take one-fifth or two-fifths or even one-half of the capital stock, provided outsiders will furnish the other half and the expert management the enterprise requires to be successful. Let it be constantly borne in mind that such management is quite as essential as capital. And if the community supplies some of the money, the enterprise will be assured of a more direct interest and heartier support than if it was wholly owned by outsiders. Farmers might take an interest in the factory by agreeing to pay for their shares partly in cash and partly in beets. Except in the very newest regions, where money is extremely scarce, the people in almost any county can raise a goodly sum of money for an investment of this kind if they really mean business. Of course the rights and interests of all the parties to such a trade should be properly seen to, but as a rule we believe in this policy of home talent and home money building up home industries. It fosters a spirit of thrift and enterprise that is often lacking in communities that are supported by industries operated wholly by foreign capital.

If, however, the people of the locality will not put up any money on any of these plans, let them not find fault that they have to depend wholly upon outside capital. Judging from some of the criticism we have heard of the Oxnards' investment in beet-sugar factories in Nebraska, some of the people of that state at least consider it almost a crime for an outsider to invest his money in new industrial enterprises! We can but believe, however, that such critics constitute only a small fraction of the population of that great state. Such critics should understand that other states are only too anxious to attract outside capital, and many towns seem to be ready to make even extravagant efforts to obtain it. But we also feel that some of such enterprising communities would accomplish more in the long run by putting more of their own money into these new industries.

WHERE AND HOW TO START A SUGAR FACTORY.

In starting a sugar factory, it is necessary to erect the plant where there is railroad competition. Transportation of beets and factory supplies is a most important consideration, requiring the lowest possible rates. The sugar itself is also a bulky product, the distribution of which among local and more distant markets must be fairly considered.

The nearer the factory can be to the beets, the better. Unlike other manufacturing enterprises, it should be in the beet fields and not close to a town. If it is possible, the sugar factory should be located in the very center of farming districts, where

at least 10,000 acres of good beet land could be controlled within a radius of not more than six miles, so that the beets can be delivered by wagon. This saves an immense amount of expense in railroad freights. Moreover, the factory cannot get quite as good results from beets grown at a distance as from those close at home that are delivered by wagon with the least delay after harvest.

An abundant supply of pure water is imperative and perfect drainage is absolutely necessary.

Plenty of pure lime rock, containing a very small percentage of silica, is required. Also coal, coke or oil for fuel. All these bulky materials should be available at the least expense for freight as well as first cost.

No factory should be built with a capacity of less than 300 tons of beets per day of 24 hours, and it should be so designed that the capacity can be increased in future at the minimum of expense. The cost of operating such a plant is 25 to 50c per ton of beet worked less than for a factory with half this capacity. The limit of size beyond which profitable economies cannot be obtained seems to be about 1000 tons of beets per day, as the latest improved large factory—Salinas mill—is practically three separate outfits of 1000 tons capacity daily, but under one roof.

It has been suggested that branch plants be established for making a crude product to be transported by rail to a central factory, where the process of manufacture and refining might be completed. Such plants for making a crude product would, of course, cost a small sum compared to the hundreds of thousands of dollars required in a large beet-sugar factory. Up to the present time, however, all experience with existing methods is against this proposition. Only the larger factories are able to run to-day in this or other countries, and many small factories in foreign parts have had to close their doors during the past few years of lower prices and increasing competition. To meet these conditions, it is imperative that the factory operate on a large scale and in such a way as to reduce to a minimum the expense per ton of beets or per pound of sugar. It costs relatively but little more for the experts and labor to operate a plant capable of working up 600 tons of beets per day than one of half that capacity. The beet is such a bulky product that every possible means must be taken advantage of to keep down the expense of handling or working it. There are many pretty theories about what might be done, but the average investor or farmer realizes the necessity of sticking close to the latest improved methods that have demonstrated by actual experience to be money makers.

Of course improvements in sugar manufacture are even more likely to be made in the future than in the past. There has been much talk of late of the new process of crystallization in motion, the Seffens process, osmosis and several others, but it costs enormously to introduce them and it is a question to be decided in each case whether the result pays in dollars and cents. American genius may yet solve these and many other problems, including the matter of small factories, refining, etc, but meanwhile, those who are in the business for revenue will let the "other fellow" do the costly experimenting. In order to compete with the sugar trust, our American beet-sugar factories have been equipped with refining outfits and thus realize the refiners' prof-

its. Mr Ware says that in Europe, the tendency is to abandon this plan, the factories making raw sugar to be shipped to refineries.

It is quite possible that the system of branch factories tributary to a central plant, similar to the Cambria factory in France, may at some time be established in the United States. The Cambria central factory is located in the midst of beet fields and is also near limestone quarries and coal mines, and has water transportation for all these raw materials. There are 16 rasping stations, the furthest being nine miles away from the central factory, with which they are connected by pipes at these stations. The beets are washed, weighed, sliced, and run into the diffusion batteries in the way common in American beet-sugar factories. The juice from the diffusion batteries is then treated with a solution of lime to keep it from acidulating and is forced through pipes to the central sugarhouse, where it is at once carried forward in the manufacturing process in the usual way, with certain modifications. This concern works up 3000 tons of beets daily and with its rasping stations gives employment to 2000 men, women and children.

How to build a factory.—All preliminaries having been satisfactorily adjusted and the company ready to build a factory, let it invite bids from the various American firms that make a specialty of this work. The announcements of these experts will be found at the close of this book. They are sufficiently numerous to insure competition and the lowest prices consistent with quality of the machinery required. Some of these concerns can also furnish expert managers to conduct the sugar factory through the first campaign, until others can be educated for the purpose. We cannot too strongly urge our readers to in this way get the benefit of all American experience, as well as competition among factory contractors and outfitters.

COST OF A BEET SUGAR FACTORY.

Kilby Mfg Co's estimate of approximate cost of building a sugarhouse and refinery of a daily (24 hours) capacity of 350 to 400 tons of beets.

Stone work, foundations and floors,	$12,500
Steel and iron, structural frame and roofs,	16,500
Brick work,	12,000
Windows and doors,	650
Hardware,	700
Painting,	800
Tarred paper for roofs,	300
Vitrified pipe,	900
Cornice, cutters and leaders,	300
Lumber,	5,000
Freights on materials,	4,000
Erecting labor of steel and iron frame,	2,000
Beet sheds and storage for beets,	5,000
Pulp silo,	4,000
Complete machinery for refinery,	225,000
Machinery foundations and masonry for boilers,	5,000
Fire clay, fire brick, etc, for boilers, kilns, etc,	4,500
Pipe covering,	2,500
Labor erecting and starting machinery,	20,000
Hardware, belting and other fixtures,	5,000
Freight on machinery,	35,000
Salaries erecting superintendent and necessary help to superintend erecting and starting of sugarhouse and refinery, including travelling and other expenses,	15,000
Total,	$376,650

The Walburn-Swenson Co writes: "The cost of machinery complete for a factory of 300 to 350 tons of beets per day, the whole to be of the very best design and work-

manship and capable of making white sugar direct from the beets, without any refining, would be in the neighborhood of $170,000 on cars in Chicago. The machinery for a factory having double this capacity would cost in the neighborhood of $260,000. The cost of a first-class brick building, including boiler house for the smaller size factory, would be from forty to fifty thousand dollars. This would also include foundations, lime kilns, etc. Just what the cost of the sheds for holding the beets would be, I cannot say, but I am of the opinion that four or five thousand dollars would be sufficient to cover this item. All the castings, etc, for the lime kiln are included in

A BIG PILE OF BEETS AT ALVARADO, CALIFORNIA,

Showing also the sluiceway of running water by which the beets are carried into the factory.

the price of machinery, and the brick work would be easily within the above cost of buildings. A building for the larger plant would probably cost $75,000. There is no doubt but what there is a great misconception as to the cost of a factory of this kind, and many people write us, thinking that with an old building and second-hand boiler and engine that has been used for some other purpose, they have a good nucleus for a beet-sugar factory, and for twenty or thirty thousand dollars it can be all fitted up. Any attempt of this kind is simply throwing money away, and it would be a great misfortune to the beet-sugar business to have it gone into without sufficient capital to erect a factory of proper size, as well as of the most modern

construction. The machinery, of course, comes very high, but it must be built in such a way that there will be no mistake about its working, as breakdowns and delays are fatal to the industry during the short season they have to work."

As competition increases the number of machinery builders and the demand for apparatus of the same kind and dimensions increases, these prices will doubtless be reduced.

ON THE MANAGEMENT OF SUGAR FACTORIES.

A factory having been well located, properly constructed and equipped, its proper management involves three essentials. First, expert or scientific oversight of the processes of sugar manufacture; second, the utmost economy, good management and businesslike methods in conducting the work of manufacture, seeing to it that there is no unnecessary expense or waste, that labor and machinery are constantly employed to the best advantage and that all the operations of manufacture are managed in the best way possible; third, proper financial or business management, in obtaining supplies, selling the product and attending to the manifold and extensive financial operations involved in so large an enterprise.

The thoroughness with which each of these essentials is observed will govern the profits of the enterprise. No one should put money into the business on the supposition that it is a bonanza that can be conducted carelessly or wastefully or in defiance of business principles. Within a few years, the number of sugar factories will be such that, with competition from abroad in the desperate efforts of the foreign sugar industry to throttle American interests, only the best-managed concerns will operate at a satisfactory profit. The fact that a plant can run only about one-third of the year, makes the "dead season" a long one, and also increases the depreciation in machinery. The earnings of the business should be sufficient not only to pay a reasonable dividend upon the capital stock, but also to keep up the plant, and to charge off liberally for depreciation. Unless this is done, after a few years repairs will not only consume all profits but perhaps require additional capital. Even in Germany, many failures have occurred in sugar factories, but in 90 per cent of the cases, bad management was the direct cause.

"Great progress has been made in the actual science of sugar extraction. Not many years since, it was considered highly satisfactory if molasses residuum represented 4 per cent of the total weight of beets worked while now in many factories 1½ per cent is the least amount that is considered to represent good work in German factories. An improved process of sugar manufacture in Germany is claimed to greatly reduce the bulk of molasses, to only 1.38 per cent of the total weight of beets worked at the factory. In a German factory working under favorable conditions during the past campaign, the beets averaged 12.92 per cent sugar and the extraction was 12.26 per cent, the loss consequently being 0.66 per cent of the weight of the beets. This loss was made up as follows: In the residuum cossettes 0.25, waste water from diffusion 0.12, filter press scums 0.25, second filter scums 0.03, which means a total of 0.65, leaving 0.01 per cent unaccounted for. There was consumed limestone 4.6 per cent weight of the beet, coke 0.69 per cent, fuel 10.2 lbs per lb beets."

Mr Ware also cites a 550-ton factory (in Germany), where the expense of factory operation of $2.03 per ton of beets in 1893 was by closer management reduced to $1.52

three years later, when it was for fuel 43c, lime and coke 16c, labor and siloing 56c, maintenance and depreciation 15c, sundries 22c.

AS TO CO-OPERATIVE SUGAR FACTORIES.

A great deal of loose talk has been indulged in upon this subject. Farmers and others who would not co-operate or work together to conduct the simplest form of a country store, creamery or co-operative marketing, have proclaimed learnedly as to the advantages of co-operative sugar factories. The ideas expressed have been in the main crude and unbusinesslike, though the object sought is highly commendable.

In this, as in all other co-operative effort, it should be distinctly understood that co-operation is not a new method of conducting business but simply provides a different method of dividing the profits of industry—to labor or produce rather than to capital. "The same principles that govern success in acquiring profit on capital, apply to the acquirement of profit to divide upon labor. Industry, application, perseverance, good judgment, all are required in the co-operative as in the existing methods of industry. Co-operation is not a means whereby the business of production and distribution will run itself and pour a golden stream into the pockets of the people. True co-operative effort is by no means independent of the everyday principles that underlie success in any undertaking or business."

Especially is this true in the beet-sugar business. The factory must be located, built, equipped and managed with the utmost wisdom and in the best possible way. This can only be obtained by employing persons of experience in the industry, preferably those who have had experience under American conditions. These experienced persons must also be reliable, or they may so conduct the enterprise as to use much more money than is absolutely essential. All these points must be properly safeguarded, whether the sugar factory is owned co-operatively, or by a stock company, or by a single individual. In either case, it must be run on the same business-like basis. Indeed, a factory that is owned co-operatively—that is, by beet growers in part in connection with others—should even be better managed than a private enterprise, because so many are ready to criticise the slightest mistake. Farmers who think a co-operative factory is one that will pay them more per ton for beets of inferior quality than a private factory can afford to pay for rich beets, will be woefully deceived. A factory can get no more out of the business than there is in it.

In a strictly co-operative factory, each shareholder has but one vote, irrespective of the amount of money he has invested. Out of the receipts of the business, the co-operative factory would first pay all expenses, a reasonable sum for depreciation and reserve, a fair rate of interest on capital, and the balance would be divided pro rata on the beets furnished, just as the co-operative creamery pays for butter. If the season is good, the beets rich in sugar, and the markets favorable, under good management such a co-operative factory might possibly pay more than one conducted by the ordinary system, but under unfavorable conditions, the loss would come upon the beet grower for the co-operative factory, as against the stockholder in the capitalistic factory. In other words, true co-operation means that the co-operators assume the risk of the *losses* as well as the *profits* of the business.

If farmers are willing to go in with all these points thoroughly understood and on a basis that will insure proper management, then co-operative sugar factories may

be attempted. To embark on so gigantic a scale on any other basis is folly doomed to failure. The whole country is strewn with wrecks of co-operative failures due to failure to appreciate the above facts, and to absence of the co-operative spirit. On the other hand, certain forms of co-operation have been made a great success in the United States. The author's book, How to Co-operate (price 50c in paper, $1 in cloth, from Orange Judd Company), may be consulted for further particulars.

BRILLIANT OPENING FOR CAPITAL.

Providing always that the American market is reserved for the product of American farms and sugar factories, it can be demonstrated by figures based on actual experience that a sugar factory enterprise is a fairly profitable investment, if properly managed from beginning to end. Without such management, even a gold mine will fail to pay.

Detailed estimates of expenses and profits vary so widely with varying conditions that it is useless to attempt to submit any here. Such an investment in a beet-sugar factory, under the above conditions, should be able to pay an annual dividend of six to ten per cent on its capital stock, after making liberal allowance for depreciation and setting aside a reserve for contingencies, maintenance and improvements. This is after the enterprise is well established. The first few years it might not do as well as this. Some failures will occur if any of the well-known essentials to success are neglected.

Under favorable conditions the industry may pay more than this. But take it one year with another, conservative management should readily divide six to ten per cent, besides keeping the property in such shape as to be able to close out the business at any time and return the shareholders one hundred cents on the dollar. To do this, however, the factory must net at least four cents per pound for its sugar and with proper legislation to protect against subsidized foreign competition and to guard the industry so far as possible against monopoly at home, this price may be expected to prevail for some years. The sugar could then be retailed to the consumer at about present prices, and American farmers, laborers and capitalists would put into their pockets the millions upon millions that now go abroad for sugar.

Without such legislation, however, this promise will never be realized. We have seen during the past three years the almost utter ruin of our old established cane-sugar industry, simply because the American market has been open to free sugar from Hawaii and to bounty-fed sugars from Europe. It cannot be too often reiterated that unless the American market is reserved for American sugar, the outlook for our domestic sugar industry, both beet and cane, is indeed poor. But protect the industry in the American market for a few years, and it will then be able to hold its own against the world. Indeed, we shall be surprised if this policy does not make America the greatest sugar-producing nation on earth.

ADVANTAGES OF THE INDUSTRY.

Assuming that the American market is assured for American sugar (unless this is done, we might as well drop the business right here and now), the advantages of the industry may be thus summarized:

To agriculture, it affords a new crop that puts into the farmer's pocket money that would otherwise go out of his community and out of the country; by thus reduc-

ing the area of other crops, it helps all farm values; the beet requires good farming and is an educator in thrift and does not rob the soil.

To labor, the beet-sugar industry offers a new field for employment of both skilled and unskilled labor of all ages, and pays a satisfactory price for it in money that would otherwise go out of the community and out of the country.

To capital, it pays a fair return and under proper management should prove an absolutely safe investment.

To other industries, the beet-sugar business contributes largely. It builds up thriving communities and gives new life to other industries. It is roughly estimated that an investment of upward of three hundred million dollars would be required to build and equip a sufficient number of factories to supply the American market with sugar, which vast sum would be distributed among the mining, manufacturing, building and machinery trades. The annual expenditure for labor and materials, such as coal, lime, coke, bagging, chemicals, oils, etc, would amount to millions of dollars.

To real estate, the beet-sugar industry creates value. Chino ranch lands that are now worth $100 to $200 per acre were hardly salable at $30 to $60 per acre before the factory was located there. Our attention has been called to a fine tract of 30,000 acres of land in California which can be "quietly bought up at $30 per acre and after a factory is successfully established will be worth at least $100 per acre." We consider this a conservative statement.

CROSS-SECTION OF A SUGAR BEET.

A section or cutting down through the middle, showing the alternate rings or cylinders of compact portions and those more translucent, the former containing rather more sugar, and the latter more salts and albuminoids. The lower or smaller part of the beet generally has a larger percentage of sugar than the larger upper part. Illustration reduced from Bulletin 27, United States Department of Agriculture.

SOME CAUTIONS IN THIS INDUSTRY.

No one state has a monopoly of the beet-sugar industry. Some Nebraska farmers have an idea that the business will be confined to their state because it has two factories in successful operation. Such people have only to read this work to be convinced of their error. Moreover, hundreds of enterprising communities are anxious to secure beet-sugar factories, and many of these will doubtless do so.

There are plenty of such communities in a dozen or twenty states where the farmers are not only ready and eager to contract to furnish any reasonable quantity

of beets for a term of years for four or five dollars per ton, but the farmers, business men and others in the community are ready to put up their money to build and equip the sugar factory. So soon as the American market is insured for American sugar many of these embryonic efforts will take on definite proportions.

The idea prevails among some people, however, that sugar factories can be had for the asking. Some of the places embraced in our list of towns that want sugar factories seem to have the idea that to be put "on the list," is all that it is necessary for them to do to secure a factory. Nothing could be further from the truth. It is well to be in this list, so that any interested parties may communicate with you, but if you think you can sit still and have a half-million-dollar sugar factory for the asking, you are very much mistaken. Why? Because, as stated in the preceding paragraph, hundreds of communities that do not believe in the "sitting still policy," are making determined efforts to secure factories.

As a rule, the most difficult thing has been to get the farmers to understand how necessary it is to prepare the soil for the beet crop. If the land is at all hilly, it should be scraped down, as the beet field should be as level as possible. Another difficulty is that the average farmer does not appreciate the necessity of care and thoroughness in every detail with the crop. In raising sugar beets, it is absolutely necessary to get rid of the idea of trying to save necessary labor. The crop cannot be slighted, as can potatoes, corn or small grains.

Another error which farmers in the older beet-growing regions are but just learning to avoid, is to be satisfied with a reasonable tonnage. Too much manure or too much irrigation will produce beets large in size and of great tonnage per acre, but such beets are often late in ripening and usually are inferior in sugar content and purity. It is impossible to extract sugar from beets when the beets do not contain the sugar.

Don't try to utilize old buildings for a sugar factory. A factory, to operate profitably, should be constructed for this special purpose, so as to save every possible item of expense. It might be possible to adapt an old building to sugar-factory purposes and perhaps save a few thousand dollars in first cost, but in nine cases out of ten, this would be "saving at the spigot to waste at the bunghole." The increased expense of operating such a plant, owing to the necessarily inconvenient arrangement of the outfit and work to adapt it to the structure, would rapidly eat up the saving in first cost and thereafter would be a constant extra expense.

Neither is it wise to bother with second-hand machinery or apparatus, unless the same is comparatively modern and strictly adapted to the purpose in view. To conduct either a beet-sugar factory or cane sugarhouse to advantage, the latest, best and most improved outfits only can be employed. This is what your competitors have now or will have, and you cannot expect to compete with them with anything else. If a second-hand outfit is offered you, be sure to get the judgment of a well-qualified expert, like Mr Salich for instance, before doing anything with it. In these days, however, such investments are likely to be unprofitable.

It may be that in the eastern and middle states, where the soil has been better cultivated and fertilizers have been used, that the land requires different treatment than at the west, where the soil has received little culture and no fertilizers. Mr Lap-

ham, speaking from results and experience in Virginia, would in no wise depart from the methods that have been best in Europe.

Beets should never be raised on a large scale by any grower the first year, unless he is willing to spend a large amount of money and does not consider the loss, if any occurs. For the average western farmer it would be advisable not to raise more than three acres the first year, and every beet grower should make it his rule to follow the advice given by the factory as near as possible, and leave his experiments until the second season.

Look out for the promoter or grower who "knows it all." The more experience sensible men have in field or factory, the more they find there is to learn.

One of the greatest needs in the American sugar industry, is for scientific and practical experts to manage the large number of factories required to produce the sugar this country consumes. To supply this need, one or more sugar schools should be established by government in connection with sugar factories. It is by such technical education that Germany has developed the industry so rapidly and successfully.

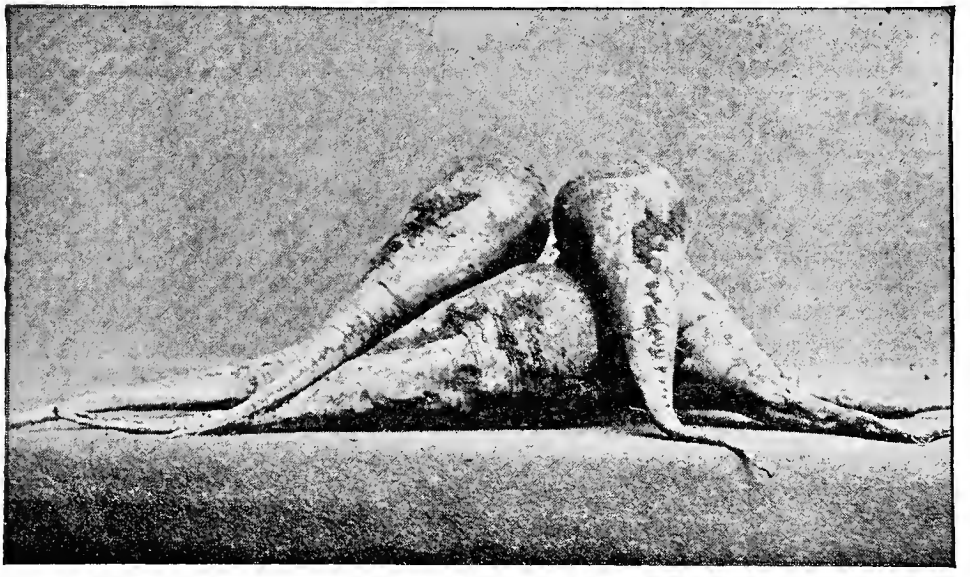
Another great need is more definite knowledge about the culture of beets. Much can be done at all of our experiment stations. The various states in which this industry is developing should also offer prizes for the best results in beet-sugar culture, to the farmers producing them for factories. The prizes should be governed not only by yield and quality, but by the intelligence and correctness with which an account is given of the methods of culture, expense of production, etc. There is a loud call for accurate data on all these points. This book is an effort to supply this demand, but circumstances in different sections vary so widely that much must be done in each state, and in different parts of each state, to get at exact facts and best practice.

No factory enterprise should expect to make money during its first two years. There is always much educational work to perform of a costly nature, although much of this work has been done by existing factories.

A gentleman who has had long and costly experience in this industry and with sugar factories writes us privately, regarding factory enterprises: "Avoid jumping to conclusions; take plenty of time in studying up the question of where to locate, especially guarding that which is most important,—an abundant supply of raw material; a good supply of water; good fuel, lime rock and coke at a reasonable cost; railroad facilities, and where you are to market the product of your factory, making a long-time contract with your railroads, on sugar out and material in, especially beets. Always select a place where the beets can be grown in the immediate vicinity of the factory, and never attempt to build a poor factory, or any at all, unless you have abundant capital to see you through the first few years, which are always largely experimental. Secure the best possible talent. A cheap superintendent is one of the gravest mistakes. A year can be well spent in investigating before starting such an enterprise. The great thing to be guarded against is, that people who have neither money nor experience in the business will become promoters and that factories will be put up that must fail."

We hope there will be no attempt to overdo this business. The over-booming, over-promoting and over-financiering of railroads and similar schemes in the west

ten and twenty years ago, that did much to bring on the depression from which the country is now happily recovering, should be avoided in this sugar industry. Let us keep the whole thing down to hard pan basis, so that every step taken will be a distinct gain, and the whole industry developed on a substantial, businesslike and permanently successful basis.



SOME NEBRASKA SUGAR BEETS.

PART FOUR.

RECENT PROGRESS IN BEET SUGAR

SINCE JANUARY 1, 1897.

Compiled from special reports to the author from directors of experiment stations, managers of sugar factories, and from many growers of beets, feeders of pulp, etc.

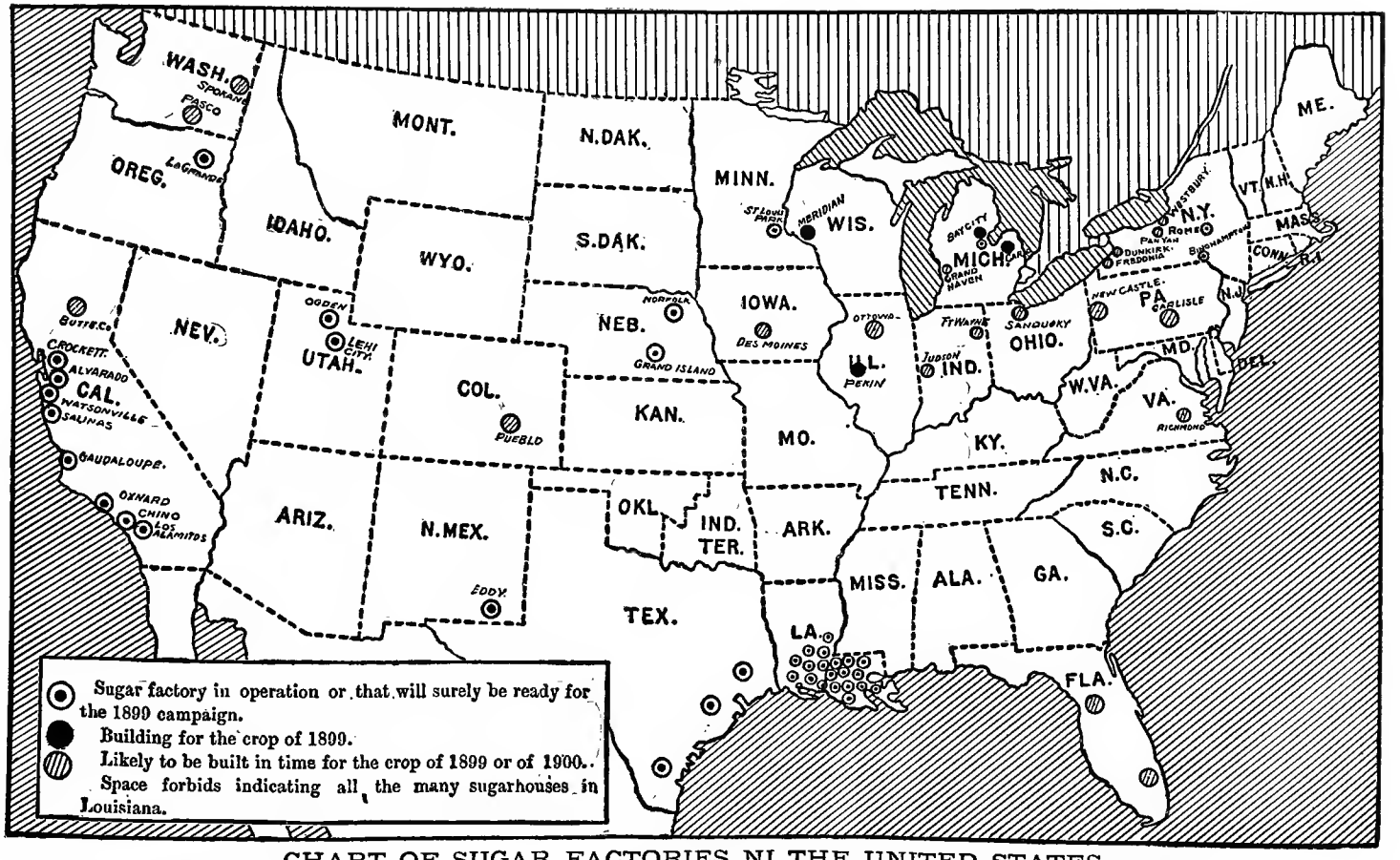


CHART OF SUGAR FACTORIES NI THE UNITED STATES.

This map indicates all the factories now in operation and some of those that will be built in time for 1899 or 1900 crop of beets. Many of the localities **that want sugar factories,** as charted on Page 42, are likely to secure sugar mills soon.

PART FOUR.

RECENT PROGRESS IN BEET SUGAR.

CHAPTER I.

EAST OF THE MISSISSIPPI.

In New England, the beet sugar industry has not obtained any footing of recent years. Some of the first experiments in the '70's were the factories at Franklin, Mass., and Portland, Me., which failed for the want of a sufficient supply of rich beets. It is true, however, that a large part of western and southern New England can grow beets to perfection, but at an expenditure for fertilizers and labor that renders it problematical whether a sugar factory in southern New England could successfully compete with those in western New York or further west. There are no large consecutive tracts of land that would be devoted to beets in southern New England, but the supply for the factory would have to come from a great number of comparatively small fields within a wide radius, which would be another disadvantage. For this and other reasons we have not urged the erection of sugar factories in that section.

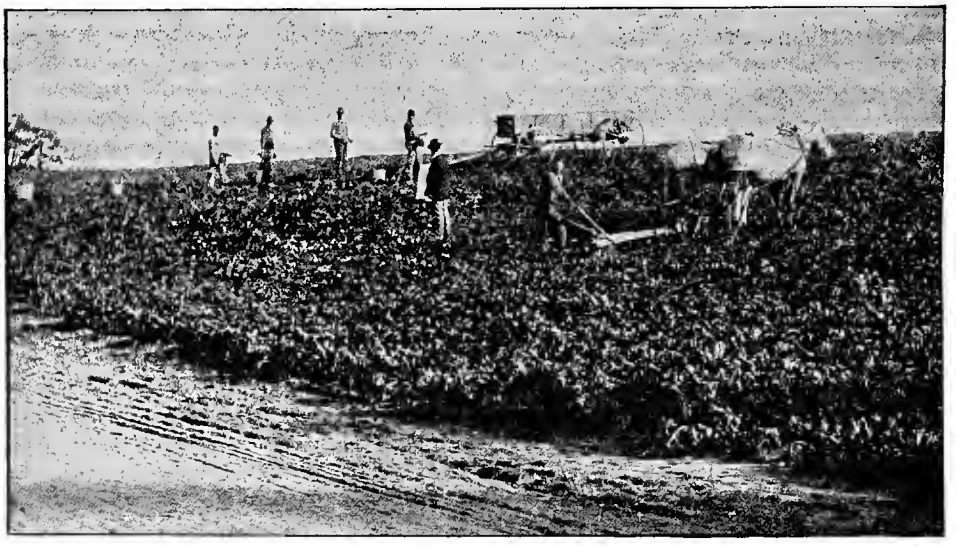
IN THE EMPIRE STATE.

New York bids fair to become a center of the new industry. Her soils, especially in the central and western parts of the state, are proving wonderfully adapted to producing a heavy tonnage per acre of rich beets. Wayne county in 1898 yielded 16 to 22 tons per acre, and the average for all kinds of soil was over 18 tons per acre of dressed beets actually shipped to the factory at Rome. These were not little plats or experimental patches, but were lots of one to 13 acres, grown by the ordinary farmer. On upland clay loam there the yield averaged 17 tons per acre, on gravelly loam upland 16 tons, sandy loam upland 21 tons, flat lands 15 tons, and one lot on muck lands made 22 tons per acre. The season was not specially favorable. These beets averaged over 15 per cent. sugar and above 80 purity, and the farmer on these lands who gets less than 15 tons per acre is disappointed.

This is as good or better than general average results even in the most favored sugar beet sections of California. How conservative is the above may be inferred from the following statement by J. L. Stone, assistant in charge of the sugar beet work at the Cornell station:

	1898	1897
Number of farmers in the state who grew beets	400	300
Number of samples received at the station to date	451	495
Number of analyses embraced in following figures	451	495
Highest sugar in beet, per cent	19.9	20.4
Lowest sugar in beet, per cent	8.2	11.2
Average sugar in beet, per cent	14.7	16.1
Purity, highest, per cent	92.8	96.1
Purity, lowest, per cent	70.2	71.5
Purity, average, per cent	?	83.5

"It is not surprising that the per cent. of sugar and purity are lower this season than last, as the weather conditions at harvest time were exactly such as to produce that result. A year ago the weather was dry at harvest; this season the soil was saturated for weeks before the beets were taken out." We doubt if a season more unfavorable to quality in the beet is likely to occur again in years. Yet even under these conditions the results of '98 are marvelous. The agricultural experiment station connected with Cornell University at Ithaca and the state experiment station at Geneva have both done an immense amount of work on sugar beets, especially during 1897-8, and plan to continue to help the farmer in mastering beet culture. The industry has passed its experimental stage in the Empire state and is now an established commercial success. Two new factories are likely to be erected in time for the '99 crop—at Penn Yan, Yates county, and Fredonia, Chautauqua county, and several more are projected. The first campaign of the



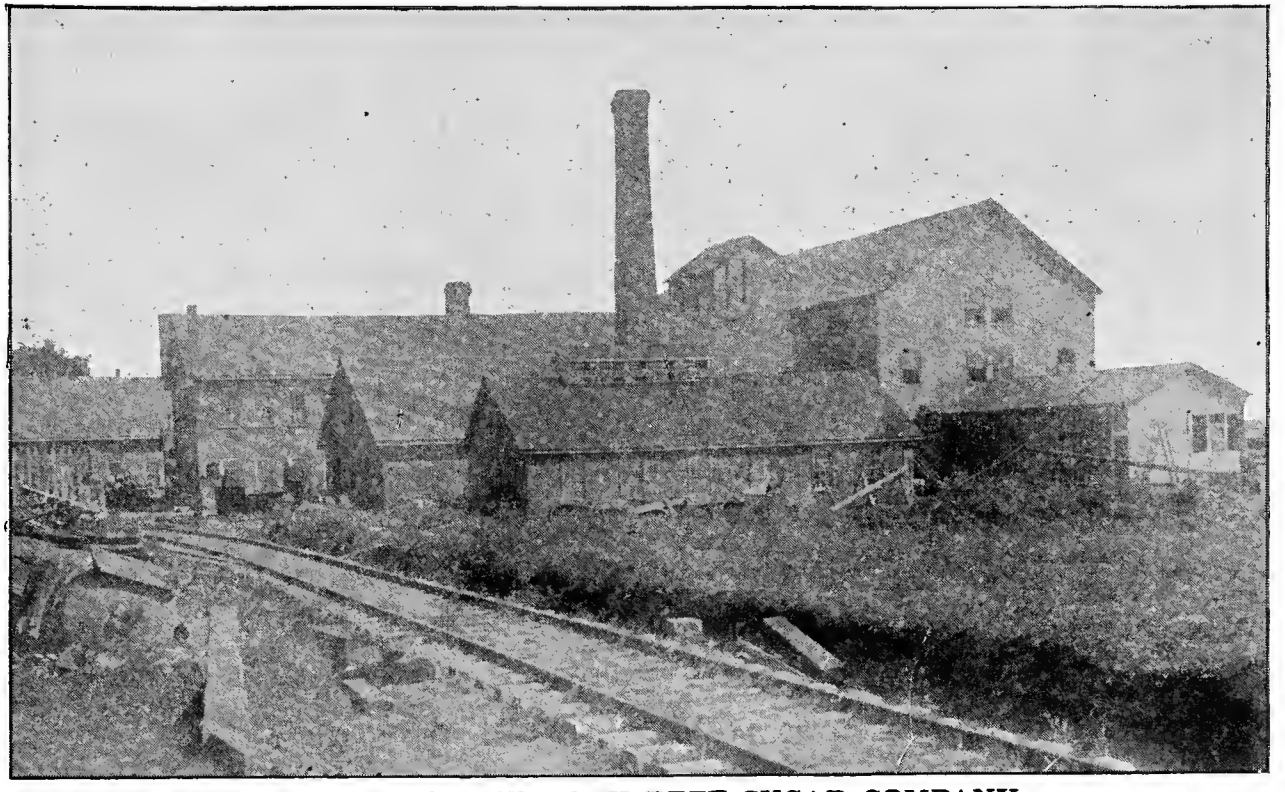
READY FOR THE HARVEST.

From a photograph taken at the Cornell experiment station, Ithaca, N. Y. The young men are selecting samples of beets from the crop.

Binghamton Sugar Company, 1898, was quite satisfactory for a beginning. The first New York beet sugar company, factory at Rome, N. Y. (see illustrations on Pages 12 and 145), completed its second campaign in December, 1898, and made the following record:

Campaigns of	1898	1897
Acres of beets grown for factory	about 1000	about 600
Tons of beets delivered	9330	4596
Av. yield per acre, tons	9 1-3	7½
Av. sugar in beets, per cent	about 12.5	about 11.9
Began making sugar	Oct. 20	Oct. 13
Finished making granulated sugar	Dec. 24	Nov. 23
Days in operation	about 64	about 40
Paid per ton for beets	$5.00	$5.00
Lbs granulated sugar made*	779,425	334,500

*This includes only about half the sugar in the beets, the other half being raw sugar, extraction of which from molasses will not be finished before April. Had the fall been dry, no doubt our entire crop would have averaged 14½ or 15 per cent.



THE FIRST NEW YORK BEET SUGAR COMPANY.

This sugar factory is located at Rome, N. Y. It is of special interest because the first of what promises to become a vast industry in the Empire state.

METHODS OF CULTURE IN NEW YORK STATE.

As this state is proving wonderfully adapted to the sugar beet, the culture of the crop has received large attention by the two experiment stations. Hundreds of farmers have conducted tests under Cornell's direction, and many experiments in field and laboratory have been conducted at both stations. The Cornell work is summarized in Bulletin 143, from which the following is quoted, to be read in connection with or in comparison with the methods described in Part Three:

"The sugar beet is an exacting crop, and persons unfamiliar with the best methods of growing it have much to learn, and will make many mistakes that will cut down the profits.

"*Soil*—Sugar beets can be grown successfully in quite a variety of soils—gravelly loam, sandy loam, loam and clay loam—though a sandy loam is usually considered best suited to the crop. Any soil that is well adapted to potatoes will raise sugar beets. While the industry is in its infancy in the state it is wise to select only those soils that are believed to be well adapted, and that are in a high state of fertility, and, so far as possible, are free from foul weeds.

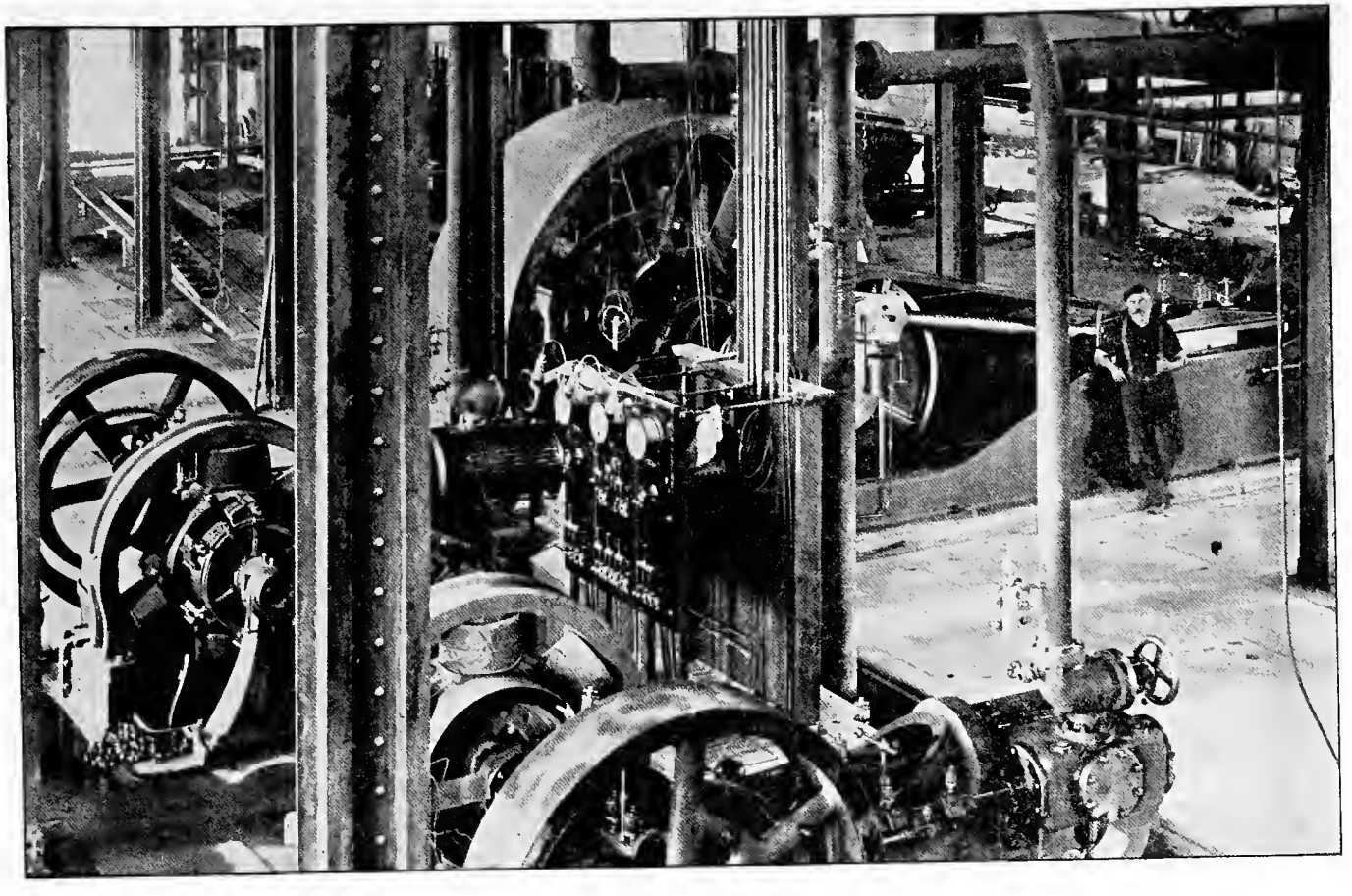
"*Subsoil*—Sugar beets should have a deep soil with a moderately porous subsoil. A shallow soil with a hard or water soaked subsoil is fatal to the crop. If the soil is not right in these respects it may often be made so by thorough drainage and subsoil plowing. In fact, land that is naturally quite unsuited to beet growing may, by these means, coupled with the growing of deep rooted plants, like the clovers, have its character so changed in a few seasons as to become excellent beet land.

"*Preparation of the soil*—The necessity of deep plowing cannot be emphasized too much in this connection. The sugar beet should bury itself in the soil the same as a parsnip, and it will do so if the soil conditions are right. If, however, the sub-surface soil is hard or saturated with water the taproot cannot penetrate into it, or if it does get down fairly well, it cannot expand freely in the hard soil, but expands in the direction of least resistance, which being upwards the result is a short root, a considerable portion of which grows above the surface of the soil. This form of beet is objectionable not only because the yield is necessarily less than with long, well formed roots, but the beets are very much less valuable for sugar making.

"It is found that the upper portion of the beet, especially that part that grows above ground, is less rich in sugar than the part growing well in the soil, while this same part is highly charged with impurities that interfere seriously with the manufacture of sugar.

"The factory people aim to keep the impurities down by requiring that the portion of the beet growing above the surface of the ground be cut off. The aim should be to so prepare the land that the root can bury itself well in the soil. Thus will be secured not only a larger yield, but a smaller percentage of waste in the crown removed. Deep plowing is therefore essential, and except where the subsoil is very porous it should be loosened up with a subsoil plow. In those localities where sugar beet growing is established, the practice of subsoiling has become general.

"It is best to plow the land deeply in the autumn, setting the plow to turn up an inch or two of new soil. The action of the winter's frosts will ameliorate this soil and render it fit for crop growing. Follow the ordinary plow with a subsoil plow, breaking up, but not throwing on top, several inches more of the hard soil. The earth should thus be stirred to a depth of 12 to 15 inches. This fall treatment is desirable on several accounts. It permits the turning up of more new soil than would be safe in the spring. It secures the more complete decomposition of any coarse vegetation that may be on the land. It breaks up the compactness of the soil so that it can receive the win-



PARTIAL VIEW OF ENGINE ROOM,

Located in main building Pacific Sugar Co.'s mill. Showing in background one of the two 1100 horse-power centrifugal engines, 100 revolutions per minute, belt 66 inches wide. In foreground two direct-connected electric engines, each with a capacity for 1000 lamps and five large motors, 270 revolutions per minute.

ter's rain and store it for the next season's crop. Opportunity is given for the re-establishment of the capillary action in the soil which was disturbed by deep plowing, enabling the plant to draw from the deeper reservoirs of moisture during the dry season.

"It is not advised to plant sod land to beets, but if necessary to do so, it should be fall plowed to give time for the decomposition of the sod, the settling of the soil and the re-establishment of capillary action. It should be plowed deep so as to have plenty of loose earth for a seed bed without disturbing the decaying sod. Sod land will probably suffer more from drouth than other, but with plenty of moisture it will grow large crops of beets, which, however, may be low in sugar and in purity on account of too much organic matter in the soil. For the same reasons it is best to apply barn manure to the preceding crop rather than to the beets, but if used on the beet land it should be applied in the fall and plowed under. Another effect of the direct application of barn manure is the tendency to produce ill-formed beets.

"Commercial fertilizers may be applied in the spring, but they should be thoroughly incorporated with the soil. Observations lead to the belief that commercial fertilizers applied on the surface have a tendency, like recently applied barn manure, to cause the development of ill-shaped roots. It is reasonable to suppose that the plant finding its food near the surface would throw out branches at this point. No doubt this tendency would be most marked in very poor soils and in dry seasons.

"If the land is not plowed in the fall, then plow deeply in early spring, taking care not to turn up much new soil. In the western states experience has taught that subsoil plowing in the spring is an unsafe practice. If abundant rains do not come after the plowing is done, to compact the soil and re-establish capillary action, the crop may suffer more from drouth than it will be benefited by the loosening of the subsoil. It would seem that in this state there would scarcely occur a season when there would not be sufficient rainfall after *early* plowing to properly compact the soil before the dry weather of summer sets in. As early in the spring as the land is fit it should be harrowed down and left for a week or ten days that the weeds may have a chance to start, when they will be easily killed by another working. If this operation can be repeated several times before seeding, the crop will be kept clean during the season with much less labor.

"The seed bed should be thoroughly prepared. The sub-surface should be fairly well compacted, the surface fine, level and free from obstructions to cultivation. It is very important that a good stand of plants should be secured and this is much facilitated by a properly prepared seed bed, but just what tools to use and how much to use them will depend upon the character of the soil and the season.

"*Seed*—It is of prime importance that first-class seed be used. The modern sugar beet is the result of a vast amount of painstaking care and labor in its selection and growth and is a highly artificial product. It therefore quickly deteriorates when the conditions favorable to the maintenance of its high qualities are wanting.

"The matter of selecting the varieties and importing the seed is usually left in the hands of the factory management. There are a large number of varieties possessing somewhat different characteristics and adapted to different classes of soils. Some are noted for their high percentage of sugar, but are light croppers and are best suited for those localities where the tendency is to grow too large a crop of coarse beets low in sugar. Others are better croppers but not so high in sugar, and are adapted to soils where the tendency is to produce too light a crop of very rich beets. The Vilmorin and the Dervaux are among the very rich varieties, but are rather light croppers; the Kleinwanzlebener, the Dippe and the Metta Kleinwanzlebener are among the medium croppers with a good percentage of sugar, while the Deprez and the Eloir are heavy croppers

but rather low in sugar. The Kleinwanzlebener and the Vilmorin have been most grown in this country and seem to be best adapted to our soil and conditions.

"*Seeding*—For good results it is very necessary to get a good stand. Without it the yield will be unsatisfactory and many of the beets, having too much room, will be overgrown, resulting in a low percentage of sugar and purity.

"It is customary to sow about 20 lbs of seed per acre, though if it all grows this is many times more than is needed. If dry weather follows the planting, only the best of the seed will germinate; if a crust is formed before the plants are up, they help one another to break through, hence the chances are much better for getting a good stand with heavy than with light seeding.

"A machine that will drop with accuracy three or four seeds in a place at such distances apart as experience shows is best for different soils, will not only save seed, but will tend to secure an even spacing of the plants in the row and greatly reduce the labor of thinning and weeding. In heavy or damp soils the seed should not be covered more than one-half to three-fourths of an inch; in light, dry soils one to two inches. The soil should be firmed over the seed, the degree to be determined by its character, light soils requiring more compacting than heavy ones. On most soils best results are obtained by planting in rows from 18 to 22 inches apart. If the rows are much further apart than this the beets cannot use all the space and the yield is lessened, or if a good yield is secured it is by growing large beets at the expense of quality.

"Such narrow rows, however, are difficult to cultivate except by those accustomed to the work and having machinery especially designed for it. When the ordinary implements of tillage are to be used it would seem wise to allow more room for working between the rows, say 24 to 27 inches, and leave the plants a little closer in the rows. Those who expect to till considerable areas of beets will do well to provide themselves with special seeders and cultivators. These seeders are made to sow either two or four rows at a time, and they may be adjusted to sow 16, 18 or 20 inches apart, spacing them very accurately. The cultivators work either two or four rows at a time and are accurately adjusted to follow the seeder, the workman confining his attention to one row while the machinery adjusts itself to the others. Of course such a cultivator can only be used to work rows that are accurately spaced by a special seeder.

"Those who have both the special seeders and special cultivators may find it advantageous to adjust the machines so as to sow two rows at either side 16 to 18 inches apart and leaving a space of 24 or more inches at the center in which the horse can travel easily while cultivating—the cultivator being adjusted the same as the seeder.

"*Tillage*—Under certain conditions of soil and weather a weeder can be used with very great satisfaction for the first working of the land after seeding, but those conditions are not always present. Should a heavy rain cause a crust to be formed and the soil again get dry enough to work before the seeds have thrown out many sprouts, the weeder can be used with great benefit to break the crust and destroy small weeds that start quicker than the beet seed. Again, on rather light land that is quite free from small stones and other impediments to tillage, if the plants have come up quite thickly the weeder can be used very advantageously to stir the soil in the rows, thin the beets somewhat and destroy many small seeds.

"Regular cultivation should begin as soon as the rows can be followed, and repeated as often as necessary to keep the surface loose and prevent weeds from gaining a foothold. Under ordinary circumstances tilling fortnightly will probably give as good results as tilling weekly, but whenever a crust has been formed by rains it should be broken up as soon as the condition of the soil will permit. The weeds will be kept in subjec-

tion more economically by frequent light tillage than by fewer cultures, which will permit them to get a foothold and require more labor in their destruction.

"*Thinning*—This is the most difficult and expensive operation in beet growing, and upon its proper execution the success of the crop largely depends. The distance between the beets in the row should depend upon the quality of the soil, as on rich, moist soil they will thrive if left much thicker than on a poor, dry soil. If planted in extra wide rows to facilitate horse culture, they may be left closer in the rows than

A FIELD OF BEETS AT THE CORNELL STATION.

The rolling lands and rich soils of central and western New York produce heavy yields of rich beets, fairly rivaling California.

otherwise. If the rows are 18 to 20 inches apart the beets should ordinarily be thinned to eight to 10 inches in the rows. The first operation of thinning is done with a common hoe, having a blade five to seven inches wide, according to the distance apart it is desired to have the beets stand when the work is complete. When the beets are well started, and usually immediately after the second cultivation, pass along the rows and with the hoe strike out portions the width of the hoe blade, leaving bunches of two or three inches containing several plants. This operation is called bunching and results in the removal of the weeds in the row and the stirring of the soil as well as the removal of most of the surplus plants. Shortly after the bunching the plants remaining are reduced to one in

a place and all weeds removed by hand pulling. As this work is usually done by cheap help it is necessary to watch very closely to see that it is well done. One plant, and that the strongest, should be left from each bunch, all the weeds should be *pulled*, not broken off, and if the soil is displaced about the young plant by the removal of the others it must be returned but not packed down hard. The thinning should be done as soon as the plants have four well formed leaves, and it is better to employ extra help rather than to delay this work. If the thinning is delayed, the beets entwine about one another so that the roots of those left are injured by the removal of the others, and if the taproot is broken the plant will never produce a well formed beet.

"Since the soil will become considerably compacted by the tramping of the workmen during the thinning, it should be immediately loosened by horse cultivation, followed by a thorough hand hoeing. This working should stir the soil three inches deep and leave the crop free from weeds. Under favorable conditions of soil and season the hand hoeing just after thinning may be the only one necessary for the crop, but if the weeds begin to start close to the rows it will be advisable to hand hoe once before thinning. Again, if rains interfere with the frequent use of the cultivator after thinning and weeds begin to show themselves in the rows, another hand hoeing must be given.

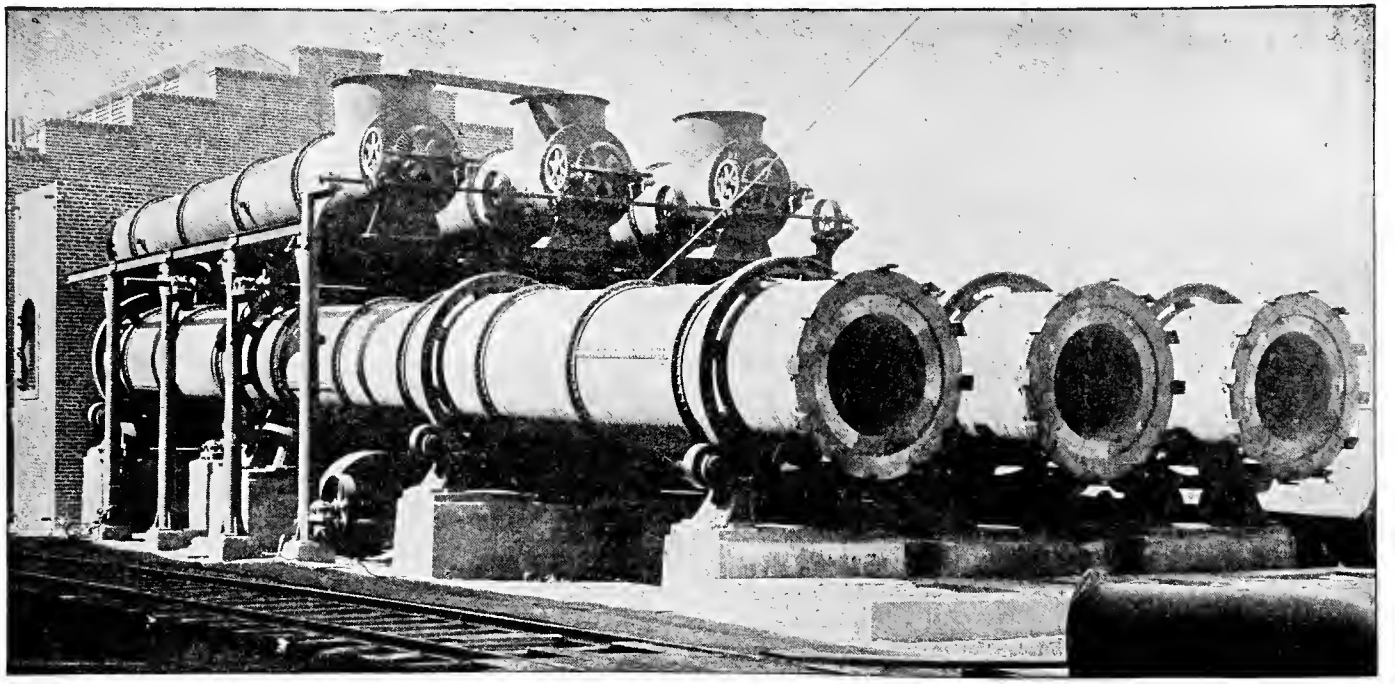
"It is impossible to say just how much tillage may be required for best results, but probably one to three hand hoeings and four to six cultivations will be sufficient.

"*The harvest* usually begins the first part of October, though with early planting it may begin a few weeks before, and it should be completed before hard freezing occurs. There are machines for pulling the beets which are said to work very satisfactorily, doing the work as fast as a team will travel. A subsoil plow, or a common plow with the mould board removed, may be used to loosen the roots. Pull them by hand, throwing into piles and topping with a knife. This knife should be heavy enough so that the crown can be removed at the earth-line by a single well-directed blow.

"It is important that farmers should understand how to properly trim the beets, for if too much of the crown is left on, carrying with it its large percentage of impurities, the value of the beet for the manufacturer is much reduced. When on a visit to the sugar factory at Rome, N. Y., the past autumn, a dozen men were found at work in the yard removing the crowns from improperly trimmed beets that had been delivered by the farmers. The factory people found it to be better economy to employ men to remove the crowns, rather than to work the beets with the crowns on and suffer the loss of sugar that would not crystallize in consequence. The farmer gains nothing by sending to the factory improperly trimmed beets or those loaded with dirt, as the state weigher samples each load, washes, and if necessary trims the sample and determines the percentage of dockage. The farmer not only gets nothing for the crown at the factory, but loses its value on the farm as stock food and fertilizer. The picture on Page 101 shows beets properly and improperly trimmed. Where a large portion of the beet grows out of the ground or is ill-formed on account of the soil having been badly prepared, the percentage of waste is very much increased.

"If the beets are not needed at the factory as fast as harvested, they may be pitted or siloed in the field the same as potatoes, and drawn or shipped to the factory later, when the pressure of farm work is not so great. In pitting it is essential that the beets shall be quite mature before harvesting, and that they be secured before freezing occurs, as immature or frosted beets will not keep well."

The Cornell station found (Bulletin 143) that, on the average, 100 lbs of the whole beet plant, as grown in New York State, consisted of 57 lbs beet without crown, 17 lbs crown and 26 lbs leaves. In 100 lbs of beets from which the leaves were removed, there



THREE ROTARY LIME-REBURNING KILNS.

At the Pacific Sugar Company's factory at Oxnard, California, the main supply of lime is burned in the kiln 80 feet high, with a capacity of 80 tons of burned lime daily, shown on Page 11. In the rotary reburning kilns above illustrated, the waste lime that would otherwise be lost is reburned and can be used again, thus effecting a great saving. Each of these kilns is 80 feet long and six feet in diameter, lined throughout with fire brick. The upper drums, each 40 feet long and four feet in diameter, serve as dryers into which the waste lime, in the condition of milk, is pumped. The stacks to carry off the gases, not shown in the picture, are 100 feet high. These kilns are fired by means of oil jets at their open ends. The hot gases pass through the length of the main kilns, vertically upward and back through the dryer and out through the stacks. The lime, after it passes through the dryer, falls into the revolving kiln below, not shown, and there is thoroughly calcined.

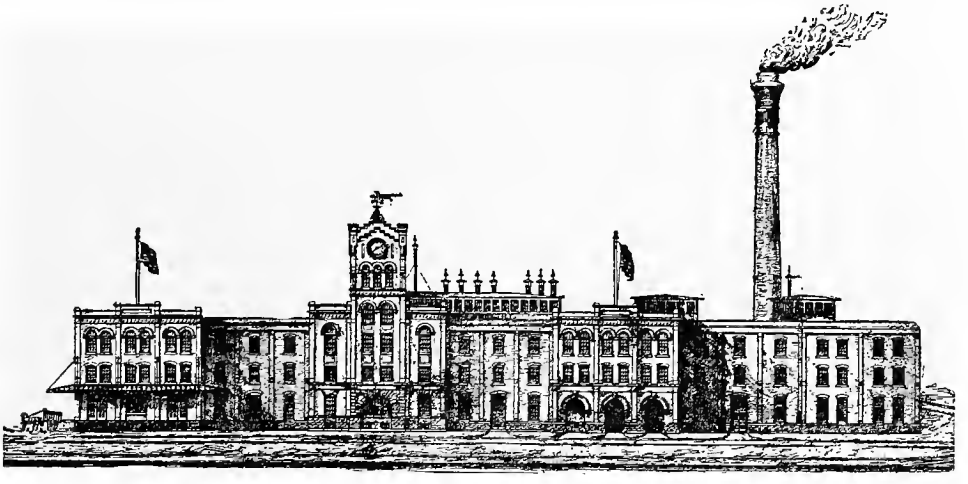
were 19 lbs of crown and 81 lbs of trimmed beets. Hence, from its analyses, the Cornell station concludes that, when freshly harvested and not withered:

	Nitrogen Pounds	Potash Pounds	Phosphoric acid Pounds	Water Pounds
1 ton of whole plants (roots, crowns and leaves) contains	7.98	11.30	2.28	1583.3
1 ton of leaves contains	12.80	21.80	2.28	1554.2
1 ton of beets (roots and crowns) contains	6.17	7.54	2.27	1593.5
1 ton of leaves contains	12.80	21.80	2.28	1554.2
1 ton of crowns contains	8.60	9.00	2.40	1594.6
1 ton of crownless beets contains	5.60	7.20	2.24	1593.2
Factory by-products.				
1 ton of extracted cossettes*, or beet pulp	1.82	1.72	.32	1828.0
1 ton of molasses*	21.40	65.20	.34	832.0
1 ton of lime-cake*	2.48	3.05	8.47	871.2

Now, if the leaves are left in the ground or fed to stock, and the crowns are fed to stock and the manure put back on the land, the soil is robbed only of the plant food in the crownless beets—say 4 to 6 lbs of nitrogen, 5 to 8 lbs of potash and 2 to 3 lbs of phosphoric acid for every ton of trimmed beets removed.

* The extracted cossettes, molasses and lime-cake were received from the Rome beet sugar factory. The extracted cossettes, or beet pulp, is a by-product of the diffusion tanks. The molasses is a by-product of the centrifugal machines. The lime-cake is a by-product of the carbonation tanks. The lime-cake contained 25.96 per cent. of lime (CaO).

NOTE.—The pounds per ton of any of the above stated plant-foods, divided by 20 will give the per cent of that plant-food in the material,—thus: 7.98 lbs. nitrogen ÷ 20 = 399 per cent of nitrogen in whole plant, or 0.399 of 1 lb. of nitrogen in 100 lbs. of the whole plant.



PROPOSED SUGAR FACTORY AT CARO, MICH.

Arrangements have about been completed for the erection of a beet sugar factory at Caro, Tuscola county, Michigan. This will be the second sugar factory in this state, the other being at Bay City, forty miles from Caro. It has been demonstrated that the soil of Tuscola county is well adapted for raising sugar beets, containing a high percentage of saccharine matter, and that the farmers are perfectly willing to make contracts for producing a certain tonnage. The proposed factory will be over 400 feet long and 200 wide, covering somewhat less than two acres of ground. The beet sheds will occupy a like area. The factory will cost when completed $500,000, and will work up 500 tons of beets per day. Over 50,000 tons will be needed for one season's run, and the farmers will be paid $200,000 for raising and delivering this amount.

MICHIGAN A GREAT SUGAR STATE.

The admirable work of the state experiment station and of farmers in testing the culture of sugar beets in the various counties has resulted in a magnificent showing. A large part of the state proves to be peculiarly adapted to the crop. The yield per acre ranges from 12 to 18 tons. In '97 nearly 500 samples from 64 counties made the remarkable average of over 16 per cent. sugar, averaging 83 purity, while 465 samples properly grown on the right kind of soil averaged 16.48.

The state bounty of 1c p lb on all sugar produced for at least seven years from March 26, 1897, led to the erection of the factory at Bay City, which closed its first campaign in '98, and its capacity is to be doubled for the '99 campaign. Another factory of 750 tons' capacity is to be built at Bay City or vicinity in time for the campaign of '99, and another at Caro, Tuscola county, of 500 tons' capacity. The labor cost of growing an acre of beets under adverse conditions at the agricultural college farm near Lansing was $29.40, reckoning man and team at 25c per hour, man alone 12½c, boy 8c, while the average yield per acre was over 14 tons. In 1898, the farmers' profits ran from $15 to $30 per acre, after allowing $6 per acre for rent, paying full prices for labor and other expenses. The greatest profits were made where women and children were hired at 65 to 75c per day. Much of the labor was done by children at a time when the schools were not in session. Altogether the industry may be said to be an established success in Michigan, and the farmers are ready to raise beets for all the factories that may be built.

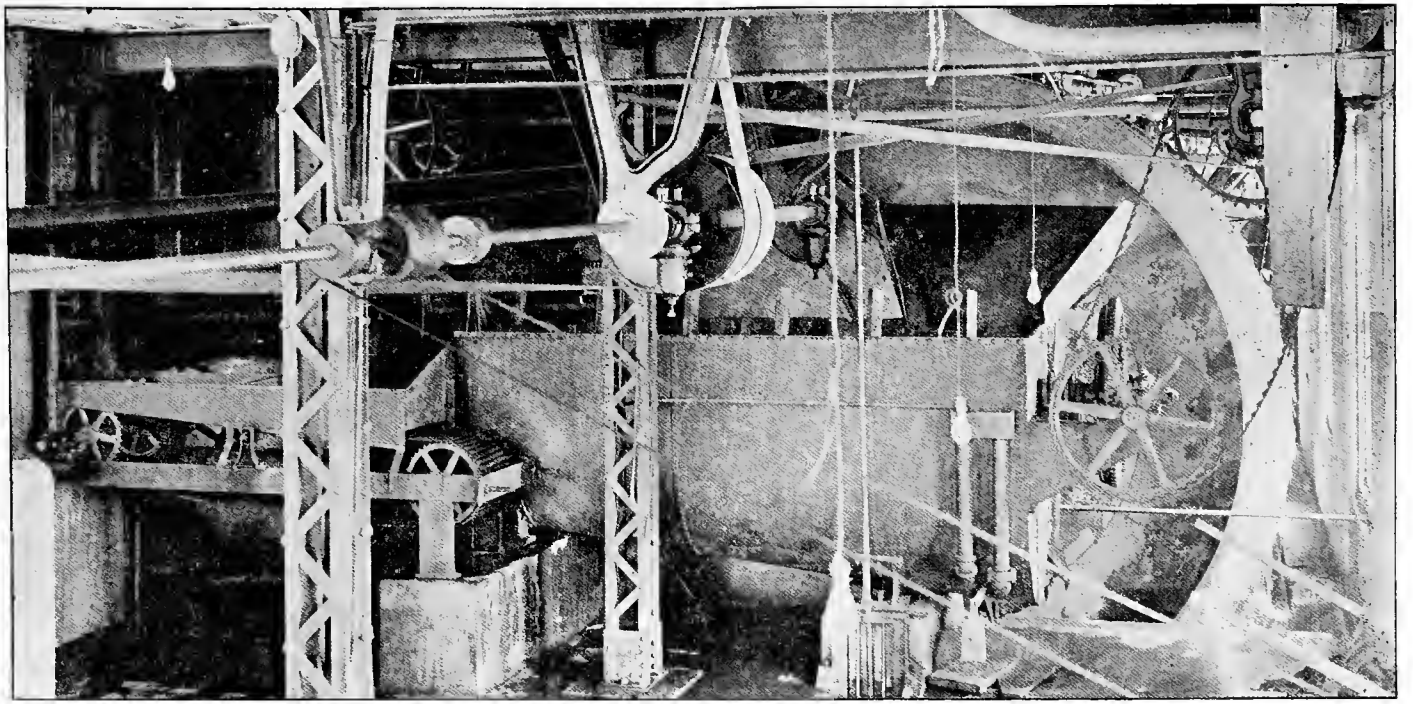
WISCONSIN EXPERIENCE HAS BEEN SINGULARLY INSTRUCTIVE

since the appearance of the author's first book in January, '97. At that time, it seemed as though the little sugar mill at Menomonee Falls, Waukesha county, as described on Page 60, would ultimately be a success. It proved, however, that some of the machinery was not properly constructed, the mill was very late in starting up and we believe the creditors came down upon it before the campaign was ended. The financial tangle has not been cleared up as we write, while some experts who have looked over the plant criticise the outfit very severely. Be it fully understood, however, that the trouble in this case was not with the farmers or the beets, but was wholly with the factory, its equipment and management, and was mainly due to prolonged lack of capital. It is too bad that the well meant efforts of the builder should have ended so disastrously. The incident emphasizes the importance of sufficient capital and proper equipment and right management in the factory as well as in the field. We let our original paragraphs on this factory stand without change, simply to emphasize the importance of the lessons taught by the outcome.

This result should not discourage the beet sugar industry in Wisconsin, for that state has shown a marvellous adaptability to the crop. The Northwestern Beet Sugar Company's factory at Merrillan, Jackson county, is to be ready for the '99 crop. It will probably have a capacity of 500 tons of beets per day and is contracting for several thousand acres of beets. Wisconsin not only has a soil and climate adapted to the sugar beet, but a considerable proportion of her thrifty farmers of German birth have had considerable experience with the crop in the old country, and are anxious to have home markets created for this new crop in their new homes.

IN OTHER STATES.

Pennsylvania is coming to the front with tests of sugar beets of gratifying quality. Of course the crop does better in some soils than in others, and yields from eight to 20 tons



MECHANICAL WASHER FOR BEETS.

The beets are usually brought into the factory in a flume of water, and are elevated by a revolving screw (see extreme left) to the top of the building, where they are delivered into this big tank. Here the beets are thoroughly washed in running water, being agitated by a revolving spindle. The washed beets then fall into the slicer, from whence the slices go into the diffusion cells. This illustration is from a photograph at Los Alamitos, but is typical of the washing device in all modern beet sugar mills.

per acre. Director Armsby of the state experiment station at State College, Center county, reports for this work the following gratifying exhibit:

	1898	1897
No. of farmers in the state who grew beets in an experimental way, about	1000	
No. of samples received at station from crop grown in	495	83
No. analyses embraced in following figures	492	83
Highest and lowest sugar in beet, per cent	17.4-77	19.7-7
Average sugar in beet, per cent	12.3	12.1
Purity, highest and lowest, per cent	98-66	94-60
Purity, average, per cent	81.7	79.7

In Ohio, the interest in sugar beets continues very keen. In spite of the extraordinarily unfavorable season of 1898, the tests made by the Ohio experiment station (A. D. Selby, chemist) showed a range of from over 8 to 15 per cent. sugar, with an average of 11.4, compared to 13.3 in '97 for the entire state. The leaf spot fungus, *Percosporabeticola*, injured beets greatly in '98. About 400 farmers have grown beets in an experimental way in both years, with results that are thus summarized in a forthcoming bulletin from the state experiment station at Wooster:

	Number samples		Av. Weight of beets ozs.		Sugar in beets, per cent.		Purity Co-efficient	
Section, etc.	1897	1898	1897	1898	1897	1898	1897	1898
Southern section	67	50	31.4	18.4	12.2	10.9	75.3	76.9
Middle section	132	153	32.6	19.6	13.2	11.1	78.0	76.9
Northern section	355	295	29.2	25.0	13.6	11.6	79.4	78.7
Entire state	554	498	30.6	22.7	13.3	11.4	78.7	77.9

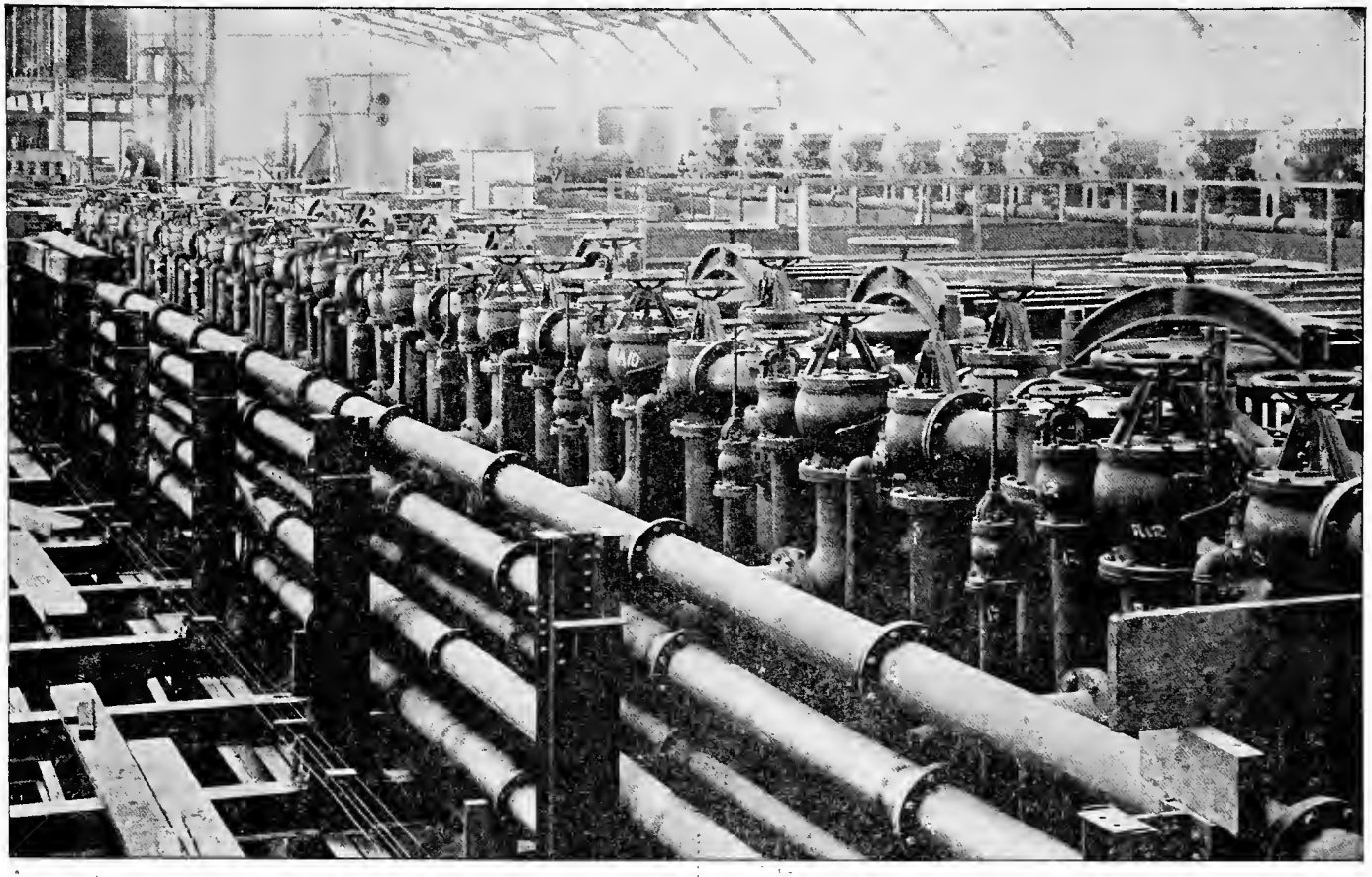
Indiana is certainly a sugar beet state, and the encouraging prospect there a few years ago is now more than confirmed. Efforts to secure factories are being made in various parts of the state and seem likely to succeed soon at Fort Wayne and North Judson. Prof. C. S. Plumb, director of the Indiana experiment station, writes us:

"The lower results of 1898 crop are due to a very warm, moist summer and fall, which did not permit the beets to properly ripen in many cases. In certain sections of northern Indiana, however, in spite of these adverse conditions, many fine results were secured, grading considerably above manufacturers' requirements."

In the following table, no averages are given. In view of the fact that many growers do not follow directions for growing the beet, so that the crop over the state is more or less improperly grown, we regard average figures as unfair and misleading:

	1898	1897
No. of farmers in the state who grew beets in an experimental way, about	1173	500
No. of samples received at station from crop grown in	425	307
No. of analyses embraced in following figures	425	307
Highest and lowest sugar in juice, per cent	17.2-6.4	22.9-6.3
Purity, highest and lowest, per cent	96.8-64	96.4-57

Illinois has an enterprising state sugar beet growers' association. In co-operation with it, farmers in various parts of the state have conducted experiments with the assistance of the experiment station connected with the University of Illinois at Champaign. During '98, the local organizations at 10 or 12 points each grew from five to 10 acres of beets for commercial purposes under direction of an expert. The tonnage was exceedingly high, but the sugar content somewhat lower than in '97. Prof. Davenport, director of the station, concludes that the results are upon the whole quite promising.



BATTERY OF DIFFUSION CELLS SHOWN IN DETAIL.

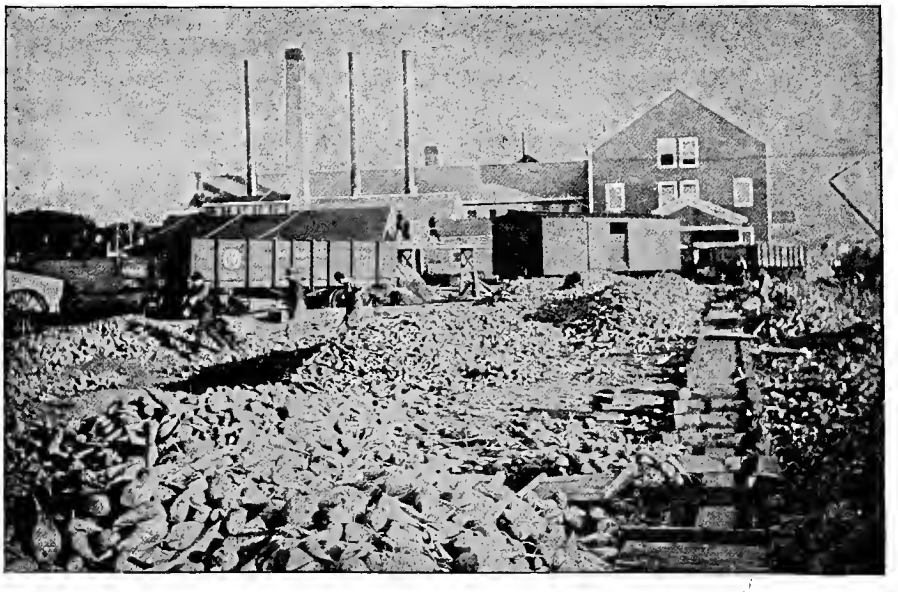
Pacific factory, Oxnard, Cal. Pipes in immediate foreground operate valves adjacent. Covers of cells proper in background. Row of filter presses higher up in extreme background.

Previous experiments have shown the capacity of many sections of the state to raise rich beets. The Illinois Sugar Refining Company has been organized to build and equip a beet sugar mill at Pekin, Tazewell Co., Ill., which will have a capacity of 350 tons per day with provision for doubling it. This concern is contracting for several thousand acres of beets in '99 and thereafter, and will pay for the same $4 per ton delivered at the factory, for beets testing 12 per cent. sugar and 80 purity, and 25c for each 1 per cent. of sugar above that.

IN THE MIDDLE SOUTH.

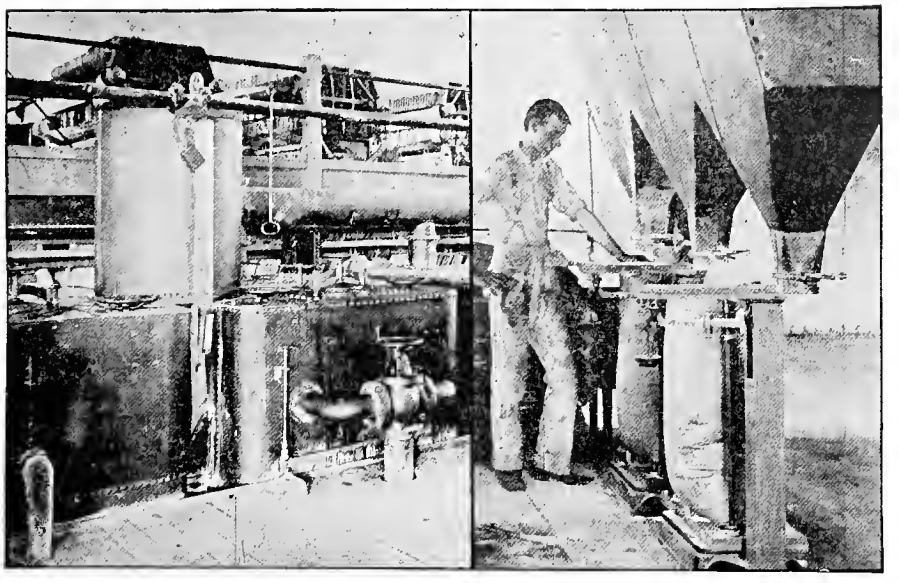
In New Jersey, Maryland and Delaware, what tests have been made in growing the sugar beet have so far been unsatisfactory in yield of beets, sugar content and purity. Another effort was made in 1898, when 51 New Jersey farmers planted their crops, but only 24 sent samples to the experiment station. These tested 7.5 to 13.9 per cent. sugar, of 70 to 88 purity, averaging 11 and 78. Director Voorhees writes us (January, 1899): "The results of our experiments in growing sugar beets are not encouraging—the sugar content is, on the average, too low to make it advisable to grow them for manufacturing purposes, besides, the yield was not large enough in the case of those which showed a reasonably high content of sugar to make it profitable for farmers to grow them at the usual price paid. I do not know at present of any parties who are contemplating the manufacture of beet sugar in this state. We have not published any bulletins on the subject, as the data have not warranted such preparation."

Efforts were made in 1897-8 to establish a sugar factory near Richmond, Va., but without success. More cultural tests are needed in both the Virginias before one can pass intelligently upon their adaptability to this crop. North Carolina and Kentucky results during the past three years have not been encouraging, though the tests were not extensive. In Tennessee the prospect is much more hopeful.



YARD OF BEETS AT ROME (N. Y.) FACTORY,

showing where the beets are shoveled into the water trough in which they are partially washed on their way to the factory.



IN THE LOS ALAMITOS SUGAR WORKS.

At the left, two carbonation tanks out of a row of eight. At right, sacking the refined sugar.

CHAPTER II.

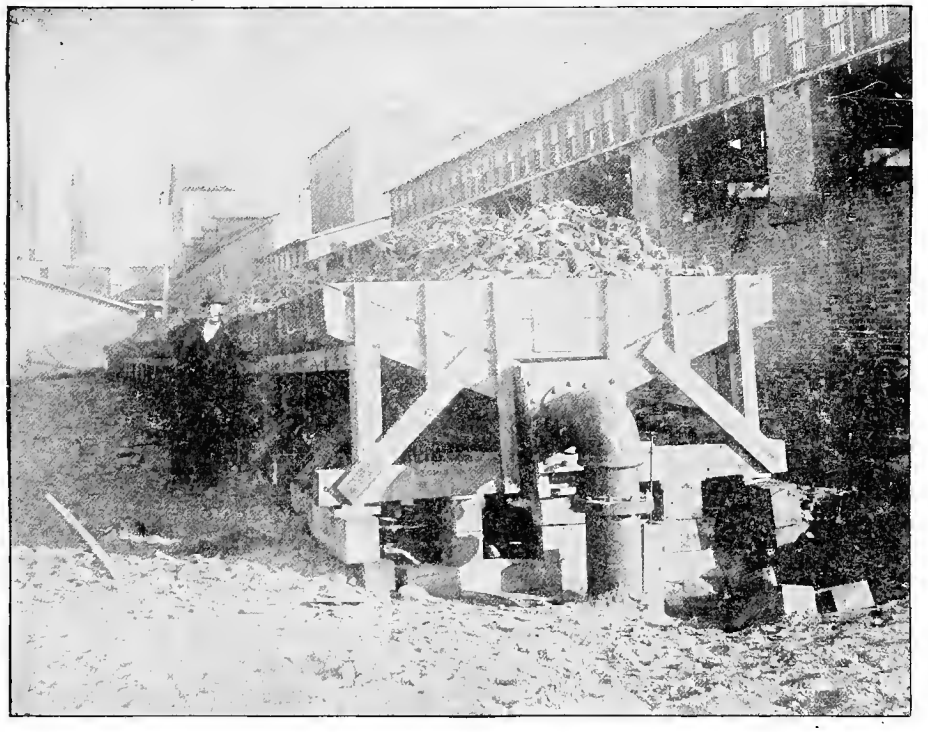
From the Mississippi to the Mountains.

GREAT INTEREST IN MINNESOTA.

For more than 10 years the farmers of Minnesota have been growing the sugar beet in an experimental way. They have been ably assisted by the state experiment station at St. Anthony Park. The results up to date were published in Orange Judd Farmer in the fall of '96 and aroused a still keener interest. Early in '98 the station published a bulletin summarizing its results for the past 10 years. This demonstrated conclusively that Minnesota is capable of producing high grade sugar beets. This last exhibit, and the Dingley tariff, removed all possible doubts and led to the establishment by the Minnesota Sugar Company of its factory at St. Louis Park, near the twin cities, for which 2200 acres of beets were contracted in this state. Two weeks before the close of the season the factory chemist stated that the average of 1100 samples was a sugar content of 14.04 per cent. and a purity coefficient of 83. This was practically the average reported by Chemist Snyder of the station for the previous 10 years, 14.22 per cent. Mr. Snyder, who deserves unstinted credit for his persistent efforts in behalf of the industry, writes us:

"This factory has made a successful run and has produced a very high grade of granulated sugar. The factory has a capacity of 350 tons per day, and it is the intention

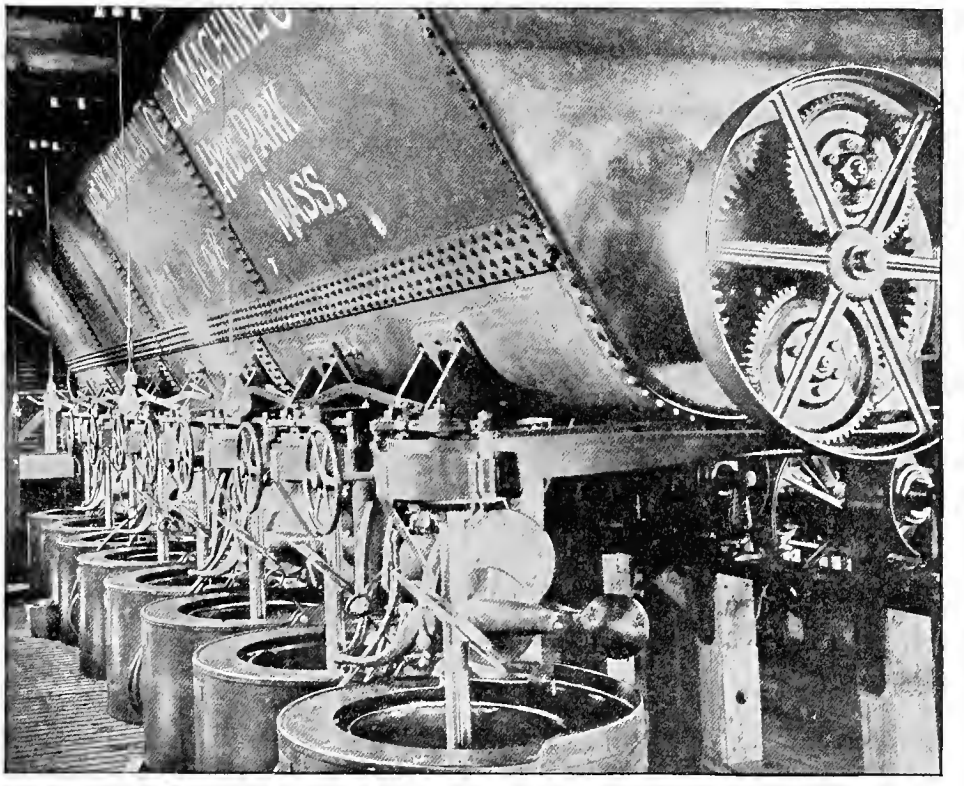
to double its capacity before the next crop is harvested. There is one encouraging feature regarding the production of beet sugar in this state, and that is, the unusually high quality of the beets. This year the early varieties of beets planted under favorable conditions were ready for the factory about August 25, which made a working season of over three months. The station has been making numerous analyses of limestone from different parts of the state with the view of locating the high grade stone most suitable for refining beet sugar. There is an abundance of lime in the state, and so far five localities have been found where high grade limestone may be obtained suitable for beet sugar purposes."



THE MINNESOTA SUGAR COMPANY.

Beet sheds and flume in foreground, factory proper in background.

The mill at St. Louis Park closed its first campaign December 10, 1898. Many farmers failed to live up to their contracts, and only 12,000 tons of beets were received from about 1200 acres, while 2200 acres were contracted. However, farmers are eager to enlarge their area for '99; many who never raised beets want to contract, and their encouragement has decided the company to double its factory, and to contract for 5000 acres for '99, in hopes of starting up in October and running to the middle of January. Factory furnishes seed at 15c per lb, and leases implements for culture at 25c per acre for each machine. It offers $3 per ton for beets containing 10 per cent. sugar, of at least 78 purity (nothing inferior to this standard accepted), $3.50 for 11-78, and $4 for 12 to 14 per cent. and 78 purity, and 25c for each additional 1 per cent of sugar above 14. As the average for 1898 was 14½ per cent., many going up to 16 or 17 per cent., it is hoped



CENTRIFUGALS AT THE MINNESOTA BEET SUGAR FACTORY.

One of the notable achievements in this industry is the equipping of our domestic sugar factories with American made machinery. Most of the new mills now being built are fitted throughout with machinery and apparatus made in the United States. The factory of the Minnesota sugar company is a case in point, our illustration showing the centrifugals made by the American Tool and Machine Co., Hyde Park, Massachusetts. The many improvements in American sugar machinery also make it very popular in both domestic and foreign sugar houses. Over $200,000,000 worth of machinery and apparatus will be needed to fit out the number of mills required to produce in the United States the sugar our people consume.

that future years will see averages of 15 to 16 per cent. The company has about $500,000 invested, its mill is first-class and it has done a vast amount of work through its agricultural department to teach farmers how to grow beets, having had three and four experts constantly employed in this way. The accompanying pictures give more facts about this promising plant (see also Page 5). The state is expected to revive the bounty of 1c per lb.

WELL ESTABLISHED IN NEBRASKA.

Nebraska had a fair season in 1897 for sugar beets and for her two factories at Grand Island and Norfolk. The 1898 campaign was entirely satisfactory in its results, farmers and mill owners are well pleased, a million dollar beet sugar factory enterprise is to be established at Ames, Nebraska, on the ranch of the Standard Cattle Company, and an immense acreage of beets is being contracted for 1899. The state experiment station continues its good work and has "made some 10,000 analyses of mother beets that have a high percentage of sugar—18 to 19 per cent." After all its trials and tribulations, the beet sugar industry is now well established in Nebraska, to the great advantage of its farmers and laborers, and at a fair profit to investors in its sugar factories.

The campaign of 1898 at Grand Island was very gratifying for the large yields per acre. One large tract, well cultivated, made 21 tons per acre, and the whole area harvested, 1970 acres, gave 18,165 tons of dressed beets, net weight at factory. These beets averaged 14 per cent. of sugar of 81 purity, or the best showing yet made. The product was 3,595,000 lbs. of standard granulated sugar, or 197 lbs. of sugar to the ton of beets, besides molasses and reworkings. In previous seasons, the factory has got from 122 to 175 lbs. refined granulated per ton of beets. In '96, it made 2516 tons of sugar from 30,100 tons of beets, and in 1897 got 3399 tons sugar from 38,600 tons of beets. The area contracted in '98 was reduced, owing to the uncertainty over Hawaii, but a very large acreage is being contracted for this mill for the '99 campaign.

The Norfolk factory also made a good campaign in 1898, receiving upwards of 50,000 tons of beets, which averaged over 14 per cent, sugar and 80 purity, and made some 10,000,000 lbs. of sugar. It has extracted 157 to 218 lbs. of sugar per ton of beets in previous seasons, the highest in '97. In that campaign, it made 3970 tons of sugar from 36,270 tons beets, grown on 4029 acres, or an average extraction of 10.95 per cent., on a run of 110 days. The campaign of '97 resulted in 1588 lbs. of granulated sugar as the mean for each acre of beets harvested. Land all through the vicinity rents for $4 to $7 an acre, averaging about $5. Says the Norfolk *News*: "The average yield of the 1898 crop has been from 10 to 12 tons, giving the farmer a gross revenue of from $45 to $54 to the acre. As the cost of raising beets, through a better understanding of the crop, learned by experience, is never more than $25 per acre, and more frequently less, it will be seen that there is no other crop that can compare to beets for profit."

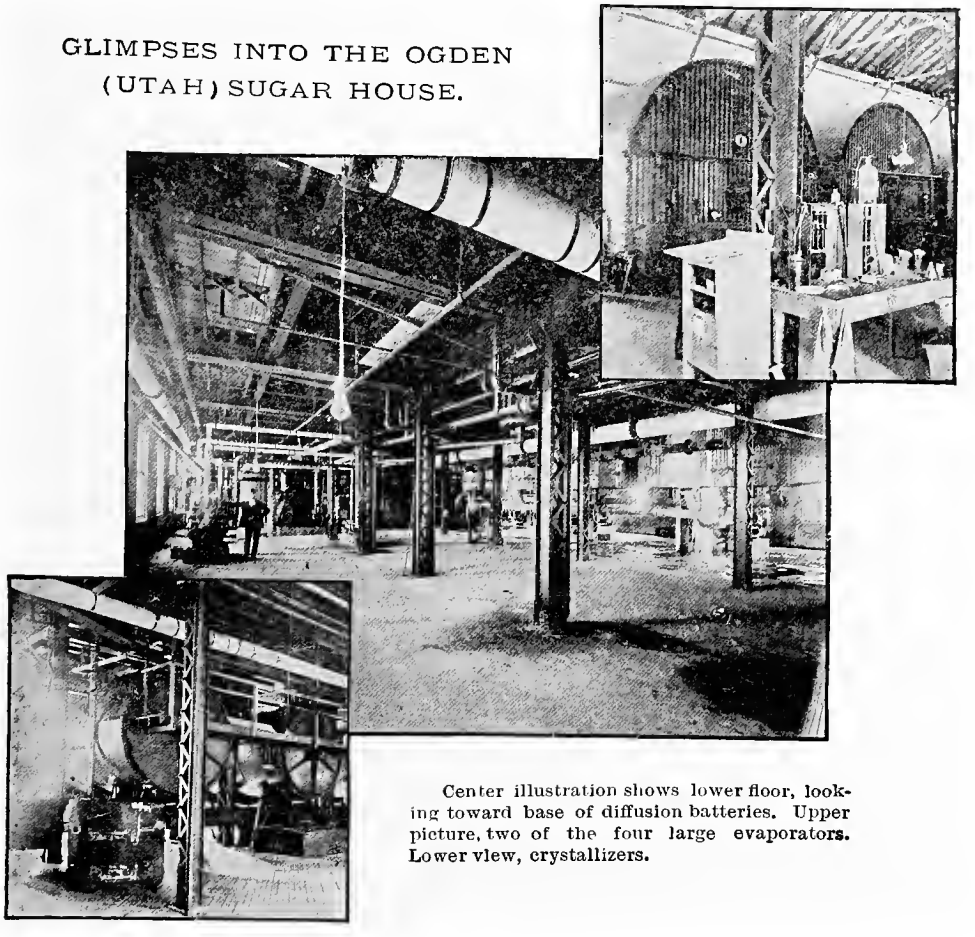
OTHER WESTERN STATES.

Iowa experience since '91 confirms Secretary Wilson's opinion on Page 68. Eighty samples were analyzed at the state experiment station by Chemist J. B. Weems, between August 27 and Oct. 29, '98, of which 38 contained less than 12 per cent. sugar and below 80 purity, while the rest ranged from 13 to 16 sugar and 78-80 purity. Out of 55 samples received from October 29 to December 14, '98, 20 were less than 12-80, 13 were between 12 and 13 and over 80, and the rest ran up to 15-17 per cent. The evidence is conclusive that Iowa is a great sugar state.

Missouri has been a center of great interest, but the results in beet culture in that state are not encouraging. We do not yet say that there are no localities in

Missouri adapted to a commercial success of this business, although Prof. H. J. Waters, director of the state experiment station, writing us Dec. 29, '98, concludes: "The results of all the work done by this station and the United States government indicate that there is little to encourage the hope that Missouri will soon become a sugar producing state." Some 1200 farmers grew beets in an experimental way in '98 and about 1100 in '97, but

GLIMPSES INTO THE OGDEN (UTAH) SUGAR HOUSE.



Center illustration shows lower floor, looking toward base of diffusion batteries. Upper picture, two of the four large evaporators. Lower view, crystallizers.

the results of '98 were not as good as the previous season. Out of 150 samples analyzed, only seven showed as much as 12 per cent. of sugar in the beet. The continued wet weather of spring greatly delayed planting and the warm wet weather in fall prevented beets from maturing perfectly.

Kansas is another state that, like Missouri, gives conflicting results. Prof. J. T. Willard, director of the experiment station at Manhattan, writes us Jan. 2, '99, "I know of no serious efforts at present to establish beet sugar factories in this state and should discourage such until a careful test of the proposed locality had been made." He submits tables of a large number of analyses of beets grown in Kansas in '98 and '97,

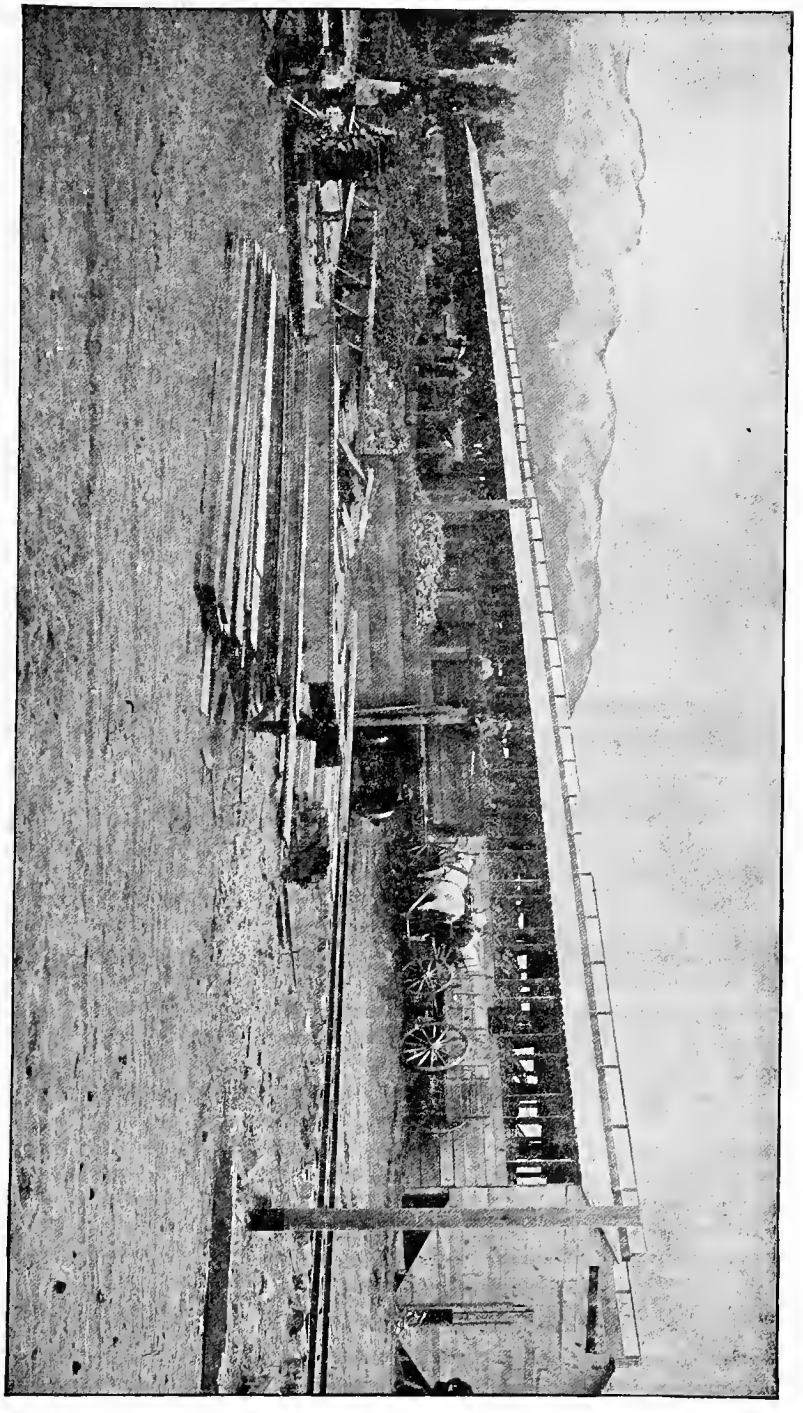
showing from 8 to 17 per cent. sugar in beet and averaging 11½ to 12 per cent., with a purity average of 76-78, and running in some cases over 90. These figures certainly show encouragement, in contradistinction to the idea that has been circulated that Kansas could not produce rich beets. A classification of the past two years' work is thus described by Director Willard:

"I have arranged this year's results by counties from northwest to southeast across the state. A study of the figures from that point of view discloses some interesting facts. Of the 20 growers living northwest of a line connecting Washington and Stanton counties, which cuts off less than one-third of the state, five or 25 per cent. of them sent samples containing over 14 per cent. of sugar, 11 or 55 per cent. of them sent samples containing over 13 per cent. of sugar, and 15 or 75 per cent. of them sent samples containing over 12 per cent. of sugar. Of the 90 growers living in the part of the state southeast of the line named, or in over two- thirds of the state, four or only about 4 per cent of them sent in samples containing over 14 per cent. of sugar, 16 or about 18 per cent. of them sent in samples containing over 13 per cent. of sugar, and 20 or 22 per cent. of them sent in samples containing over 12 per cent. of sugar. The line named is approximately parallel to the isotherm of 70 degrees for the months of June, July and August, and about 200 miles southeast of it, as located by Dr. Wiley. It would seem that northwest of the line the prospect for successful beet production, especially by irrigation, is very good. The advantages of a successful sugar beet factory to a locality are very great. but the injury of a boom collapsed is only too well known to our citizens. If the experiment station saves us from the latter it will repay its cost for many years; it stands ready to assist to the former if its analyses of properly grown beets point to commercial success in that line. Let every locality hoping to establish this industry, first thoroughly test its soil capacity and the willingness of its citizens, by showing that it can raise the necessary raw material, before it puts money, or more likely bonds, into an expensive factory."

Colorado has certainly demonstrated her adaptability to the beet sugar industry. Large crops of rich beets can be grown in a variety of places. The average quality of sugar upon 600 fields or plots of beets grown in 1898 was over 15 per cent. of sugar of over 80 purity, and the yield was from 12 to 20 tons per acre, average 16 tons. The results in some sections are astonishing, notably in the Arkansas, Platte and San Luis valleys. In each of these localities, the farmers are ready and eager to pledge the necessary acreage for one or more factories which could be located convenient to cheap and good coal, lime and water. "As high as 36 tons per acre have been obtained under irrigation in Weld and Larimer counties, and a shipment of these beets to the Grand Island factory in Nebraska resulted in an average of 13 lbs of pure granulated sugar to 100 lbs of beets, or 9,360 lbs of refined sugar per acre." (?) The Colorado experiment station at Fort Collins makes the following report:

	1898	1897
No. of farmers in the state who grew beets in an experimental way, about	600	275
No. of samples received at station from crop grown in	850	225
No. analyses embraced in following figures	454	156
Highest and lowest sugar in beet, per cent	22-8	17-6
Average sugar in beet, per cent	15.4	10.8
Purity, highest and lowest, per cent	91-50	89-46
Purity, average, per cent	80.1	73.6

It is probable, in fact certain, that more people raised beets than the figures given above, but as they made no report we cannot count them. The figures for 1897 include a great many green crops sampled early in the season; more than half the samples are of this kind. The average of the ripe crops is 12.8 per cent. sugar in the beet and 78 per cent. purity. In 1898 the samples were not taken until most of the crops were ripe. The year 1897 was very unfavorable for sugar beets, while 1898 was rather favorable than otherwise. Had every analysis of each year been included, the above figures would be scarcely changed.



NORTH BEET SHED AT THE OGDEN SUGAR MILL, UTAH.

Certain sections of Wyoming produce heavy crops of rich beets, especially under irrigation. The same is true of Idaho, Nevada and North Dakota.

In South Dakota, many experiments have been tried for several years which demonstrate the adaptability of the sugar beet to that region. In '97, probably 1000 farmers grew beets in an experimental way, and out of 300 samples received at the state experiment station, Director Shepard reports that the sugar in the beets ranges from 12 to 23 per cent., average 16.4, with a purity of from 72 to 92, and average 86, a remarkably high showing. The past season 25 farmers have been growing the beet on a commercial scale, from one-fourth to one acre, to determine the profits of the crop, at Brookings, Huron, Yankton, Sioux Falls and Aberdeen. Samples from these crops show from 13 to 26 per cent. sugar of 77 to 94 purity, also a fine exhibit.

"Montana can grow a sufficient quantity of beets in any one of several agricultural valleys to supply several factories. The beets would meet the requirements for sugar content and purity." Thus writes Director Emery of the state experiment station at Bozeman. He submits figures showing a large number of tests in '97 and a lesser number in '98, that show from 10 to 20 per cent. sugar in the beet of from 63 to 96 purity, or an average of about 16 per cent. sugar and something over 80 purity. "The lowest results are obtained where alkali is excessive and serves to lower the average."

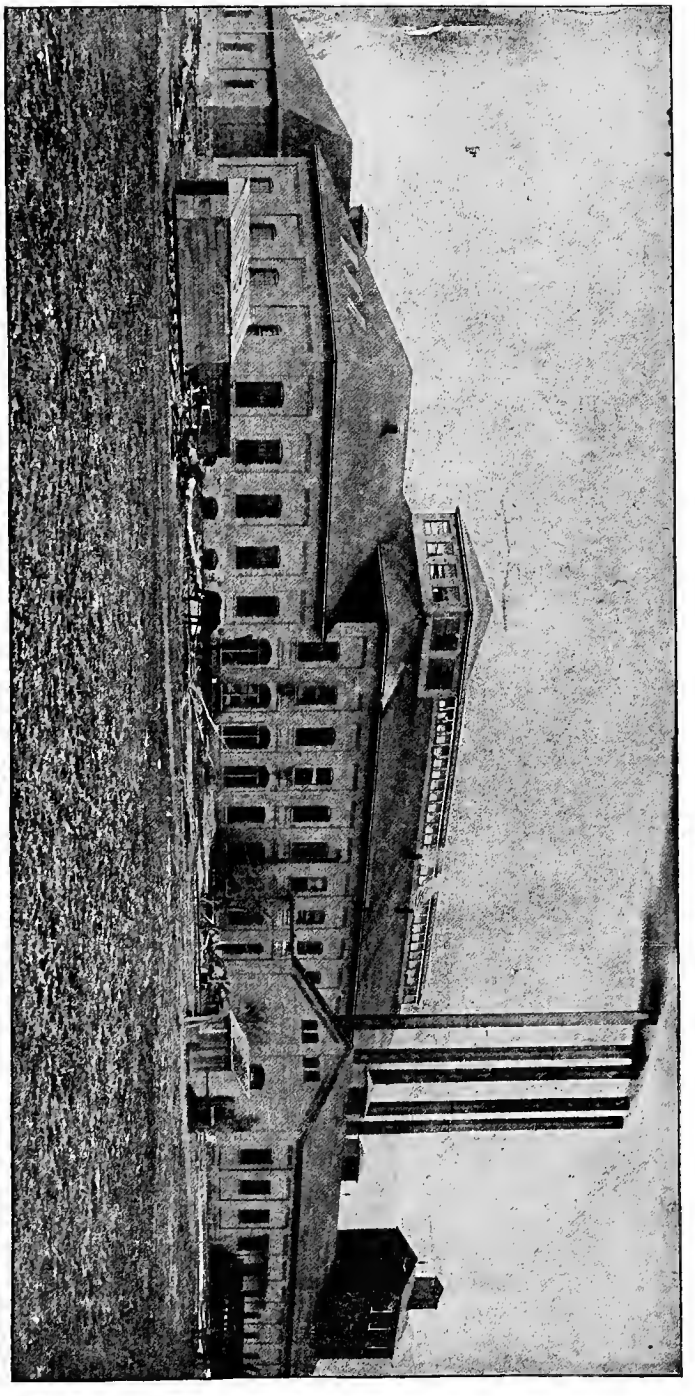
In the southwest, Oklahoma and the extreme west of Texas will probably be found to contain much good sugar beet land. Arizona certainly does, but of course needs irrigation.

New Mexico has one sugar factory at Eddy, in the Pecos valley, southeastern part of the territory. The country is so new that the settlers have much to learn about growing the crop, and the factory has hardly had a fair chance yet, but there is every reason to believe in the ultimate success of the industry in that section. One carload of beets in '96 averaged 24 per cent. sugar of 92 purity. The factory sliced 134 tons per day the first season and 160 its second campaign. Some 30 tons of mother beets, planted from seed in February, '98, averaged 19-84. The '98 crop on 2000 acres ranged from 7 to 15 tons per acre, averaging 16 per cent., and with favorable conditions should make 20,000 tons.

	1898	1897	1896
Acres of beets grown	1500	1900	1500
Tons of beets produced	9000	5700	7800
Average yield of beets in tons per acre	6.0	3.0	5.2
Per cent of sugar in beets	14.5	14.2	16.2
Per cent of purity in beets	87	80	82
Per cent of sugar extracted from beets	10	10.53	5.77
Pounds of sugar made per ton of beets	200	210	116
Pounds of sugar made per acre of beets	1200	632	600
Tons of sugar produced	900	600	450
Days factory ran	60	40	60

PROSPERITY IN UTAH.

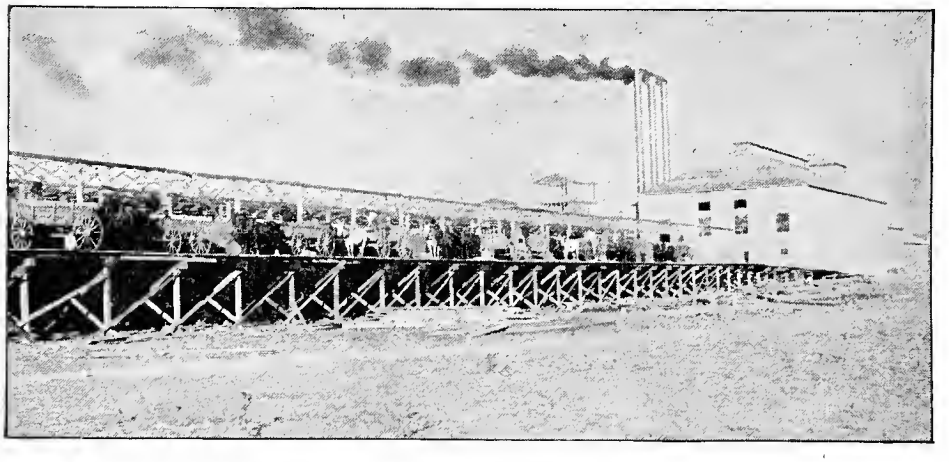
We are now able to add the results of its last three campaigns to the exhibit of Utah's first sugar mill at Lehi, published on Page 58. Its '96 and '98 campaigns were both very successful, but the '97 season was bad for beets and unsatisfactory for the mill. The '98 campaign was the most successful season for both farmers and factory since it started in '91. Many fields averaged 15 to 20 tons of dressed beets per acre. While only about the same amount of beets was received as in '96, improvements in quality of beets and in methods of agriculture and manufacture have helped along. The amount of sugar in the beets has averaged 14½ per cent., compared to 12.6 last year, 13.9 in '96, and around 11 per cent. in the previous seasons. This factory has paid particular attention to the selec-



OGDEN SUGAR CO.'S FACTORY AT OGDEN, UTAH

tion of mother beets and propagation of the best seed, with encouraging results specified. A considerably larger area has been contracted for the '99 crop. Farmers have been well pleased with the results, while the factory has also earned a handsome dividend. Its reports enable the author to make the following comparisons:

	1896	1897	1898
Acres of beets grown	3,200	2,500	3,200
Tons of beets produced	43,500	17,500	43,150
Average yield per acre, tons	13.5	6.75	13.5
Per cent. of sugar in beets	13.9	12.6	14.5
Purity of sugar, per cent	82.5	82.0	83.0
Crude sugar per acre, lbs	3,753	1,701	3,915
Refined sugar per acre, lbs	3,096	1,395	3,549
Refined sugar per acre obtained, lbs	2,862	1,355	3,422
Began making sugar	Sept. 15	Sept. 25	Sept. 8
Finished making sugar	Jan 23	Nov. 23	Dec. 28
Tons of sugar made	4,578	1,858	5,000
Per cent. sugar extracted	10.6	9.9	11.8
Lbs sugar extracted per ton of beets	212	198	236



UNLOADING BEETS AT THE LA GRANDE FACTORY, OREGON

The beet sheds are 400 feet long. Factory in background, viewed from southwest.

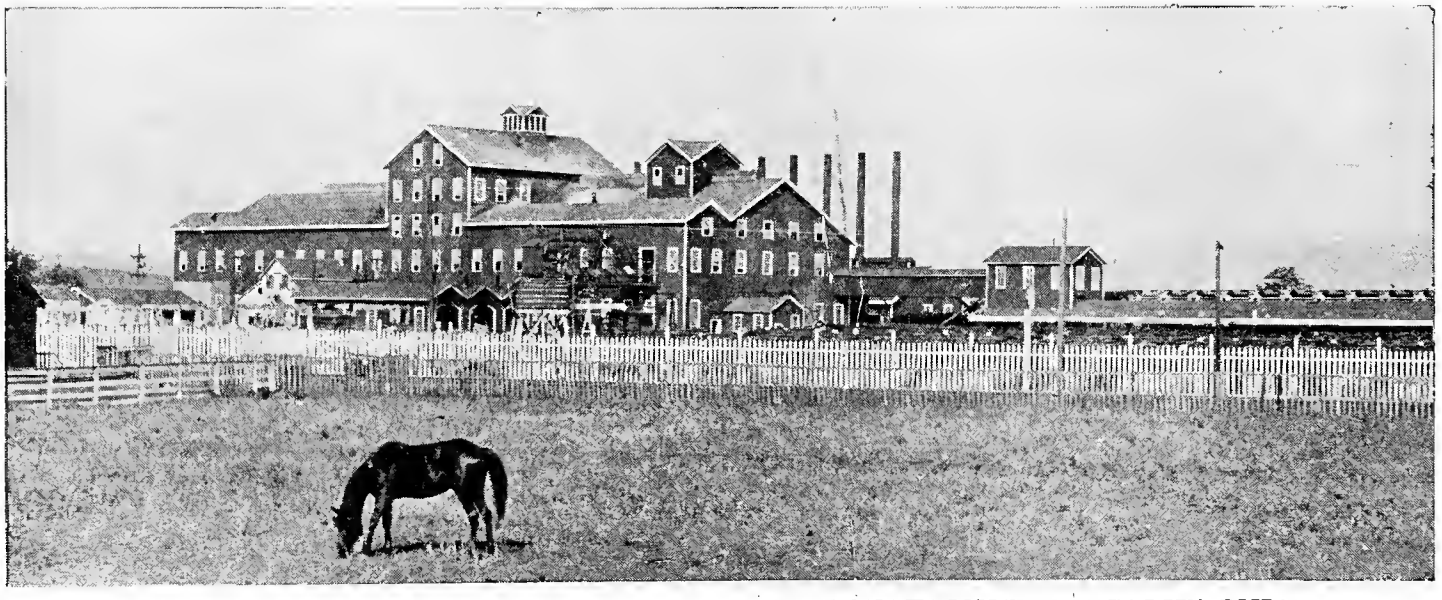
The second sugar mill to be established in Utah is the Ogden Sugar Company, whose factory at Ogden made its initial campaign in 1898. The company was not organized until December, '97, but in spite of that late date, succeeded in getting about 2000 acres planted in northern Utah, the crop from which has to be hauled from one to 100 miles. The manager wrote us November 3, 1898:

"We are just now in the midst of the 1898 campaign, having worked something like 12,000 tons, and expect to work altogether about 25,000 tons; the highest yield to an acre has been 30 tons, the lowest 7½ tons. The per cent. of sugar varies from nine to 20 per cent.; the average is about 14 per cent., with an average of 80 per cent. coefficient purity. We pay $4 per ton for beets delivered at factory. The sugar produced is excellent. The campaign began Sept. 27, and we expect it to end early in December. Our valley is

not very old, and we do not anticipate any trouble from frost, hence have not taken any precaution to store beets against frost. Next year, when we expect a great quantity of beets, we will doubtless investigate that matter. The farmers who have intelligently taken care of their crops are very well satisfied, but those who have failed to do so are correspondingly dissatisfied, and attribute the result to almost any other cause than their own neglect. The factory is not in a position to make a truthful complaint for a first year's run, but should we have to compete against cheap land and cheap labor productions of the West Indies and Philippines, of course the entire enterprise would cease, the money invested be lost and the source of revenue for 1000 or more farmers be absolutely stopped. We expect next year to grow about 5000 acres, and with the average produced this year, we expect a yield of over 60,000 tons of beets. We shall commence our campaign as early as Sept. 1, and hope to run at least 100 days."

THE PULP DUMP

At the Minnesota Beet Sugar Factory.



THE SPRECKELS BEET SUGAR FACTORY AT WATSONVILLE, CALIFORNIA.

ITS TEN YEARS' RECORD.	1897	1896	1895	1894	1893	1892	1891	1890	1889	1888	Tots or avs
Acres of beets grown,	10,305	11,017	7,264	11,013	5.156	4,254	1,443	2,900	1,778	2,100	57,230
Beets produced, tons,	110,786	154,936	77,145	143.802	65,396	54,415	19.251	18,715	13,472	14,845	672,763
Average tonnage per acre,	10.75	14.06	10.61	13.05	12.68	12.79	13.67	6.13	7.58	7.07	av 10.84
Paid per ton for beets,	$4.00	$4.00	$4.00	$4.87	$5.00	$5.00	$5.00	$4 44	$4.95	$4.83	av $4.47
Total paid for beets,	$443,144	$619.744	$308,580	$700,316	$326,980	$772,075	$96,255	$84,095	$66,686	$70,701	$2,989,576
Average paid per acre,	$43.00	$56.24	$42.44	$63.55	$63.40	$63.95	$68.35	$27.22	$37.52	$34.15	av $49.98
Campaign at factory began,	Aug 29	Aug 12	Sept 3	Aug 16	Sept 14	Aug 31	Sept 15	Sept 13	—	—	—
Campaign ended,	Dec 25	Jan 29	Dec 14	Mar 24	Jan 12	Jan 23	Nov 20	Dec 4	—	—	—
Length of campaign, days,	118	170	102	220	120	146	66	82	—	—	av 128
Hours run in campaign,	2,483	3,446	2,063	3,506	2,479	2,909	1,422	1,449	—	—	av 2,469
Raw sugar made, tons,	14,888	19,528	10,915	12,047	7,769	5,695	2,170	2,127	—	—	av 9,392
Tons of beets to one ton of raw sugar,	7.4	7.9	7.0	11.9	8.4	9.5	8.8	8.7	—	—	av 8.9
*Tons of beets to one ton of refined sugar,	8.1	8.6	7.7	12.9	9.1	10.4	9.6	9.6	—	—	av 9.8
Average weight of beets worked daily, tons.	1,075	1,083	897	985	635	449	326	312	—	—	av 720
Average weight of raw sugar made daily, tons,	144	136	127	82	75	47	37	35	—	—	av 85
Raw sugar per acre, lbs,	2,889	3,545	3,005	2,187	3,013	2,677	3,007	1,466	—	—	av 2,724
Refined sugar per acre, lbs,	2,643	3,243	2,750	1,993	2,757	2,450	2,751	1,341	—	—	av 2,442
Average annual wholesale price of granulated sugar in New York, in cents per lb,	4.5	4.5	4.2	4.1	4.8	4.3	4.6	6.2	7.6	7.0	—

*Figured at 100 lbs of raw sugar averaging 91½ lbs of refined.

CHAPTER III.

ON THE PACIFIC COAST.

Washington is the only state on the Pacific coast, which, at this writing (January, '99) has not one or more beet sugar mills. It is probable, however, that two factories will be built in Washington in time for the '99 crop, one in the Yakima valley and the other at some other point in eastern Washington. Experiments continued over a series of years indicate that in Washington, as in Oregon, there is some danger of a second growth of beets, owing to warm rains in the fall, on the coast slope, but this trouble seldom occurs east of the mountains.

Oregon has proven to be a remarkable state for raising a heavy tonnage of rich beets, where the culture has been properly followed. The first factory in the state was built in 1898 at La Grande, Union county, northeastern Oregon, not far from the Idaho line, by the Oregon Sugar Company, as is described in connection with the accompanying illustrations. Considering the haste with which this enterprise was started and the inexperience of the farmers in growing beets, its first campaign was quite satisfactory. The company writes us as follows:

"Our beet crop for 1898 was very light, only some 8151 tons being harvested, from which we manufactured 1,850,000 lbs. dry granulated sugar. Drouth (unusual) and the hurried work necessary to get everything into operation during this season, and the ignorance of the farmers in regard to the growing of this crop, are the causes of the shortage in tonnage. Another cause was the mistaken idea that beets could be grown like wheat, in tracts of hundreds of acres. Instead of the growers confining themselves to 10 or 20, or possibly 40 acres, they contracted to grow 100, 200, and in some instances as many as 600 acres of beets. The result was, few hands to thin, cultivate and harvest, and the crop was neglected. For next season a strong effort is being made to divide up the large areas into smaller tracts, and induce bona fide settlers to come in and work up this land to sugar beet culture. Indications are that there will be quite a number of people, who understand this industry, come here during the winter, prepared to begin operations early in the spring. Although our season was a short one, the run was very satisfactory in every respect. The yield of sugar per ton of beets was large. The beets yielded a heavy per cent. of sugar, averaging 15.72 per cent. with 84.6 purity."

An average of within a fraction of 16 per cent. sugar in the beet and 85 purity is absolutely unprecedented in the beet sugar industry of the world. If such results can be obtained during a first season with unusually unfavorable climate and all other conditions against a good crop, certainly the industry ought to be a success in future years, as its agricultural details become better and better mastered.

A MARVELOUS SUCCESS IN CALIFORNIA.

All that was said about the beet sugar industry in the Golden state in my book two years ago (see Part 2, Chapter II herewith) has been more than confirmed by experience since. And this in face of the fact that, owing to the worst drouth in 40 years, the season of 1898 was agriculturally the most disastrous that the beet sugar industry of California ever saw. Without exception, all of the old factories in the state have largely increased their plants and output since 1896, and several new mills have been constructed, or are now being completed for the '99 crop. A number of other factory enterprises are also being worked up, and will doubtless be built, unless Congress puts a premium on free

sugar from the tropics. The illustrations in this book give full particulars about both new and old factories. The mill at Spreckels is the largest beet sugar factory in the world, considerably exceeding the largest institution of its kind in Europe. The great plant of the Pacific Sugar Company at Oxnard, with its daily capacity of 2800 tons of beets, is two-thirds as large as that at Spreckels (see Page VIII). The other mills have a capacity of 1000 tons of beets daily.

California has the great advantage that in some sections planting can begin on the upland and earlier and warmer soils in January and February and continue upon the lower and colder soils until well into May. This enables the harvest to begin in August and continue until January again. No protection, except sheds to keep off the rains, is required for the beets after they are harvested. Director Hilgard adds:

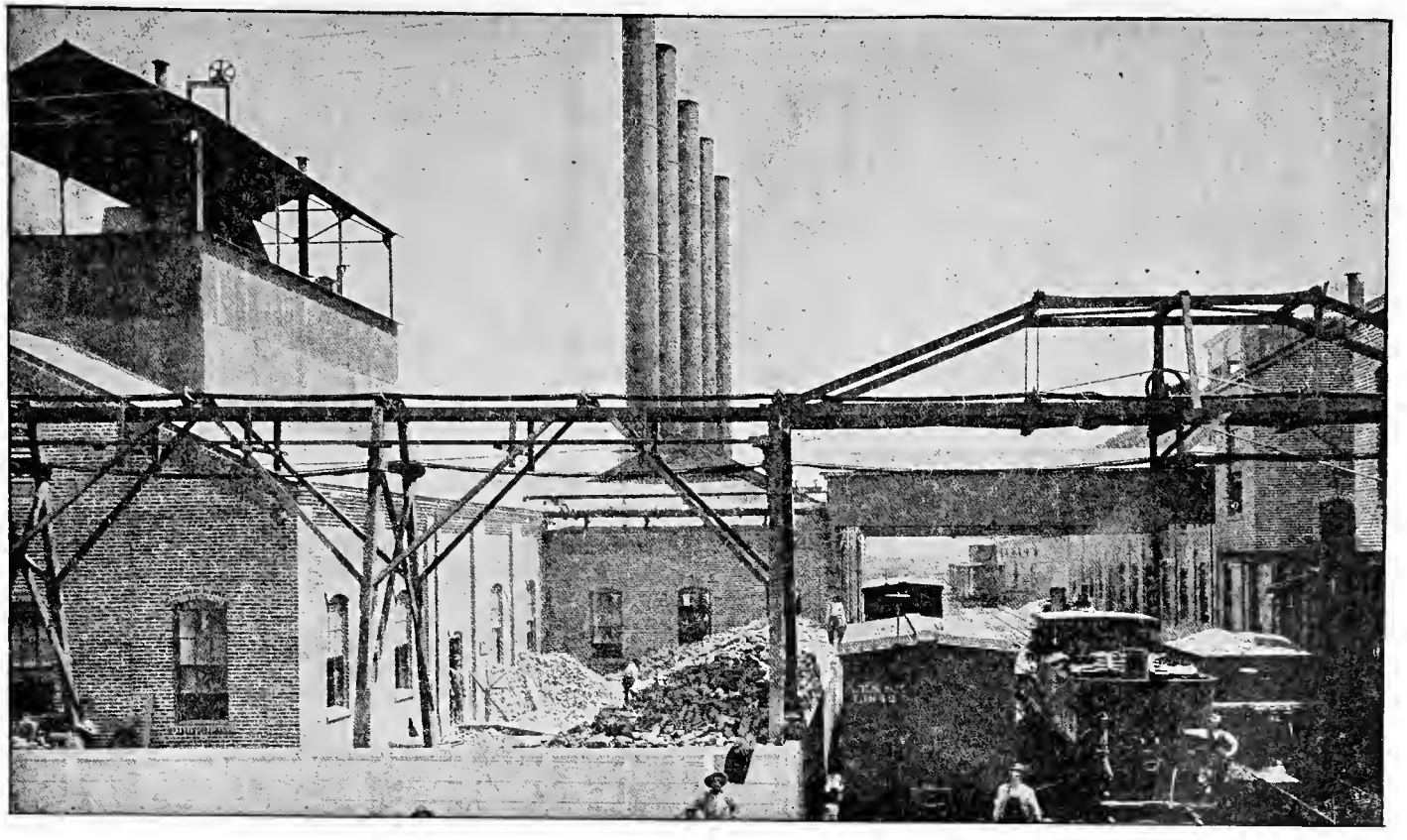
"The perfect ventilation so secured maintains the sugar content of the roots unchanged for a much greater length of time, the temperature being sufficiently low to prevent a tendency to sprout until about the middle of February, when, as a rule, the beets are still in better average condition than where they have to be stored underground. There is thus no difficulty whatever in lengthening the campaign in California to full six months, and probably more, if early shipments from the southern part of the great valley should be found feasible.

"In respect to the growing and cultivation of the beet, also, California enjoys a not inconsiderable advantage in the fact that the absence of summer rains in ordinary seasons does away with a large proportion of the expensive manual labor in hoeing and weeding, which forms a considerable item in the cost of production both in Europe and in the east. With thorough preparation of the soil, a single weeding is sufficient, where elsewhere three are necessary in order to carry a clean crop to maturity."

Much stress is also attached to the higher sugar percentage and greater purity secured by California beets. It is true that many crops have been delivered to California factories that contained from 15 to 18 per cent. sugar in the beet with a purity coefficient of 80 to 85. In Europe, the percentage ranges from 12 to 14, and at the best Silesian factory, at Stobnitz, runs as high as from 15 to 16 in good seasons. In view of the remarkable richness of beets that are being grown in other parts of the United States, notably in New York, Michigan and Oregon, it may be a question how far California possesses any advantage in this respect. Time alone will tell.

It is certain, however, that California possesses a large area of magnificent beet land, "especially in the valleys of the coast region, from Mendocino to Los Angeles, and the Sacramento and lower San Joaquin valleys." The success of the crop in southern California on properly selected soils has also been most marked. Prof. Hilgard points out that less than one-tenth of the entire valley area in the state would produce the present estimated annual consumption of sugar in the United States. To test the availability of alkali lands for beets, many experiments have been carried on at various sub-stations under Prof. Hilgard's direction, and he concludes: "It has been proven beyond question that sugar beets of good, and even high grade, both as to sugar and purity, may be grown on lands containing as much as 12,000 pounds of alkali salts per acre to the depth of three feet; provided, that the percentage of common salt in the soil does not exceed an average of .04 per cent., or 1500 pounds, per acre. Even this may not, of course, represent the maximum compatible with good quality, but is the highest figure that has yielded such, viz., good quality, in the course of our experiments thus far."

The historic Alameda Sugar Company's mill at Alvarado continues so successful that $200,000 were spent in doubling its capacity for the '97 campaign. A picture of the mill, as enlarged, is given on Page 33. The campaign of '96 lasted 154 days—Aug. 24 to Jan. 24. The average purity in 1898 was 83, very good. The company is contracting for 10,000 acres of beets for '99, and with a six months' campaign, expect to work up 100,000



REAR VIEW AT LOS ALAMITOS SUGAR WORKS.

Lime kiln at left, boiler house in center, coal bin in foreground, carloads of sugar on track side of main factory. The two pictures on Page 129 give a good view of the main structure. By having the boiler house apart, there is no fire risk whatever in the main building. Hence no insurance is carried on these modern sugar houses, which being built wholly of iron, brick and concrete are incombustible and also contain nothing that would burn.

to 125,000 tons of beets, for which $4.50 per ton will be paid, same as in '98. The drouth of '98 caused only 4000 acres to be harvested out of 6000 contracted, and reduced the yield seriously, the product being 3634 tons granulated sugar, compared to 5000 tons previous season.

	1898	1897	1896	1895	1894	1893	1892
Acres of beets grown.....	4,000	4,808	3,500	2,400	2,894	1,803	1,594
Tons of beets produced.....	36,500	48,773	48,500	27,400	39,800	20,300	15,000
Av. yield per acre, tons.....	9.1	10.2	13.9	11.4	13.7	13.7	11.3
Av. per cent. sugar in cossettes	14.	14.2	13.9	14.1	11.56	15.5	12.53

The New Union Sugar Company is under the same management as the Alameda Company. Its new mill of 500 tons' capacity, and capable of being doubled and tripled, is located on a fine tract of land in the northern part of Santa Barbara county, four miles south of the line between San Luis Obispo county and six miles from the Pacific ocean. It is situated by a lake 11 miles in circumference, and within a radius of 50 miles are 130,000 acres adapted to the crop, traversed by two railways. There is an unlimited supply of water for irrigating purposes. The Union mill is contracting for 8000 acres of beets at $4 for '99. Secretary Coffin writes us in January, '99: "Since August, we have been plowing 50 acres per day with our steam plow tackle, similar to that used by Mr. Lilienthal. We plow from 12 to 15 inches deep. There are about 4000 acres of our own that will thus be plowed. The tract is being plowed and ditched by accurate survey in accordance with an irrigation system which covers the entire tract."

ELEVEN YEARS OF THE WATSONVILLE FACTORY.

A picture of the beet sugar mill at Watsonville, California, is given on Page 170, together with its record for the ten years 1888 to '97 inclusive, as originally compiled by the author. Last year (1898) was the worst season known in the state for 40 years, owing to drouth, which caused an unfavorable sugar campaign. Hauling beets to the Watsonville mill began August 5, closed November 5, '98, with a total of 57,761 tons of beets delivered from 7200 acres, at $4 per ton. Under the ideal conditions of 1896, the 25,000 acres contracted for 1898 should have yielded 350,000 tons.

The table (Page 170) shows a steady development and affords the best data extant for judging of the ups and downs of this industry, from both the farmers' and manufacturers' standpoint. It will be noted that during these 10 years the yield of beets on nearly 60,000 acres has averaged 11 tons per acre, including good, bad and indifferent seasons. The farmers have received from $4 to $5 per ton, or an average of about $4.50. This has amounted to from $27 to $68 per acre, averaging $50 per acre.

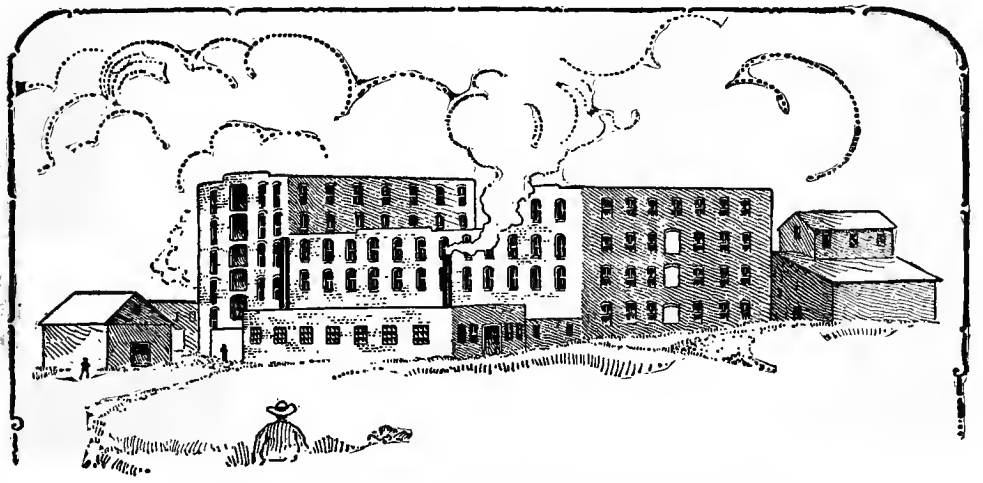
The cost of production and delivery of beets to the factory has varied in that vicinity from $20 to $35 per acre, including the labor of the farmer himself or his family and teams, as well as his hired help, all at current prices. It will be seen that while the crop afforded comparatively small profits the first season, once the culture of the crop was fully understood and the industry well established, it proved to be the most profitable staple crop the farmer could raise. This one mill has paid $3,000,000 for this new crop and as high as $700,000 in a single year. But for the establishment of the factory in that vicinity this vast sum would not have been paid to these farmers, but would have gone out of the country to pay for imported sugar.

It required 7 to 12 tons of beets to make one ton of sugar, and the greatest variation was in two succeeding years. This shows the wide fluctuation in quality of beets, due to climatic conditions. The average of 8.9 tons of beets to make one ton of raw sugar, or of 9.8 tons to make one ton of refined sugar, is decidedly better than the best fac-

tories in Germany can show during the same eight years. It will be noted that the quantity of raw sugar produced per acre varied from about 1500 to a little over 3500 lbs during the eight years, averaging 2700 lbs, with some decrease in the amount of refined sugar. This is just about half the production per acre from cane on Hawaii. It is interesting to observe also that the price of sugar fell 40 per cent. during these 10 years and is to-day lower than ever.

Many other facts of interest are shown by the table. The run of 220 days by the factory on the 1894 crop was the longest campaign ever made by any beet sugar mill in the world, but the actual hours run in the '96 campaign of 170 days were almost as many, when the factory sliced an average of nearly 1100 tons of beets per day of 24 hours, from which 136 tons of sugar were made daily.

Regarding the season of 1898, P. W. Morse, the agricultural superintendent, writes: "The drouth was severe on the farmers, yet taught a needed lesson in compelling attention to the necessity of irrigation in our valleys that have a semi-arid climate. The drouth also forced an unwelcome fallow upon the lands of many farmers, which, how-



SKETCH OF THE UNION SUGAR WORKS

Now being completed for the 1899 campaign, with a capacity of 1000 tons of beets per day. Main building 240x110 feet, of brick and steel. Located in northern part of Santa Barbara county, California, six miles from the ocean.

ever, is not an unmixed evil, as among other minor benefits farmers will be partly compensated by an increased yield next year. For 1899 we shall pay $4.50 per ton of 2000 lbs for beets. With sufficient rainfall this winter, we shall have between 40,000 and 45,000 acres planted. Under favorable circumstances this should insure full campaigns for both the Salinas and Watsonville factories, which are under the same management."

SUCCESS OF THE ESTABLISHED FACTORIES.

The Chino Valley Beet Sugar Company's factory at Chino, in San Bernadino county, has had two good seasons and one poor one since the exhibit on Page 48 was made up of its first five campaigns. In 1896, it worked up about 66,000 tons of beets, the crop being reduced by drouth. Its campaign of 1897 was almost ideal, the factory running 151 days on 97,197 net tons of beets that contained an average of 15.1 per cent. sugar and

yielded 24,303,000 lbs. of standard granulated. There were harvested for the mill 9678 acres, out of 10,000 contracted. The gross weight of beets delivered by farmers on the Chino ranch to the Chino factory from July 15 to Dec. 20, '97, was 53,624 tons, and the net weight for which they were paid was 50,639 tons. The difference of nearly 3000 tons, or 5.47 per cent., represents the tare, or reduction for weight of dirt on beets, poorly topped beets, etc., as determined by the tare-man appointed by the beet growers' union. These beets averaged 14.9 per cent. sugar and 78.5 purity. The net price received by the farmers averaged $4.23 per net ton, or a total of $210,862. Nearly as much more was paid for some 50,000 tons additional received at the factory from other localities. The bulk of the beets was delivered in September, October and November.

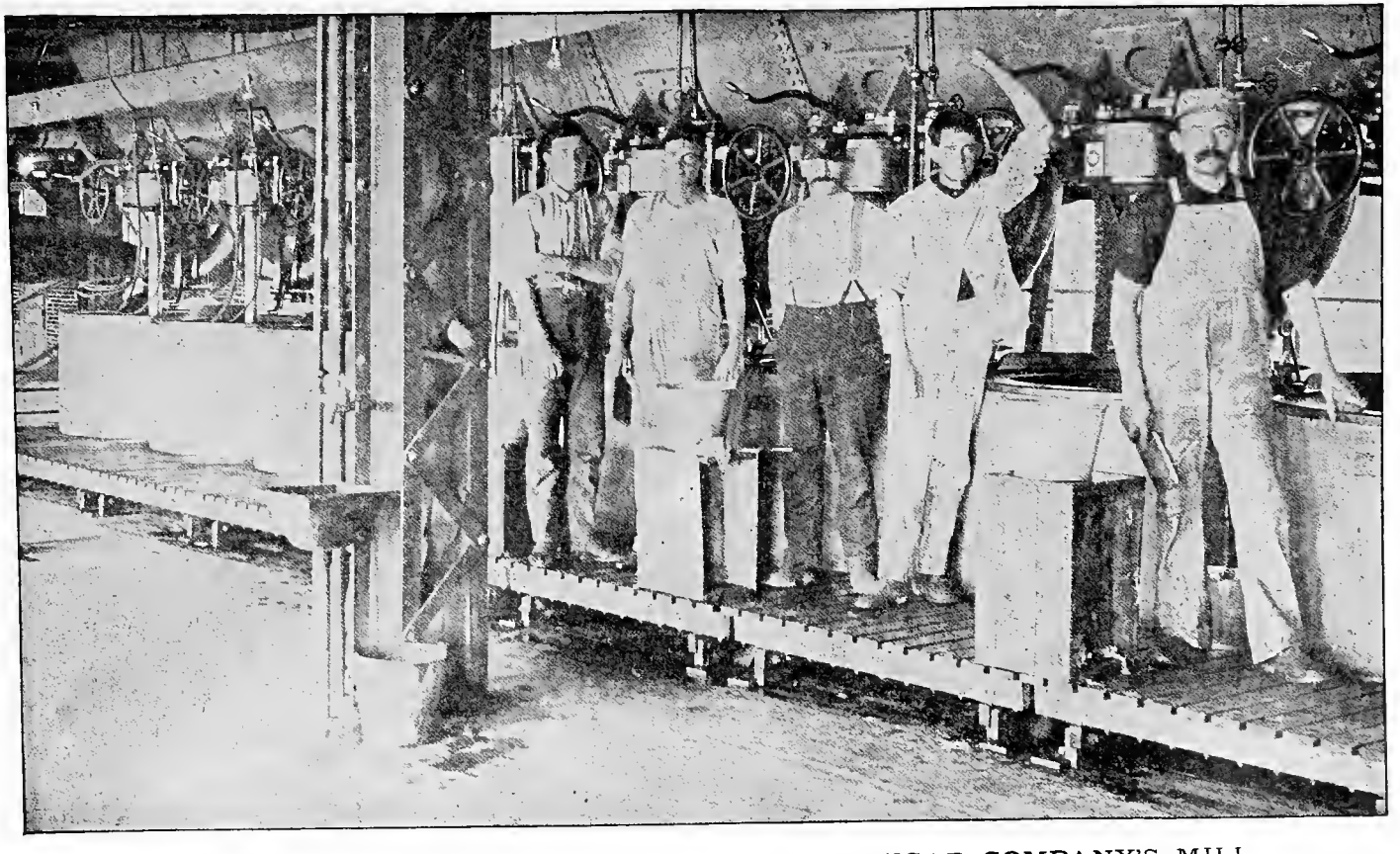
In 1898, the unprecedented drouth caused the results of the previous campaign to be just about cut in two. The output of sugar was 12,063,782 lbs. A total of 47,302 tons of beets was consumed, and the percentage of sugar was approximately 13 per cent. The farmers received $192,272 for their beets, for which they were paid a fraction over $4 per ton. For 1899, the Chino factory is contracting for 12,000 acres and hopes to get 150,000 tons of beets. Arrangements for irrigation have been made by many growers, so as to be independent of drouths.

The Los Alamitos Sugar Company has completed its mill, an imperfect sectional view of which, to explain the process of manufacture, is given on Page 37, and a preliminary notice on Page 50. For its first campaign of 1897, 2800 acres of beets were harvested, that yielded 29,542 tons, containing an average of 15.73 per cent. of sugar in the beet, and making a total product of a little over 6,000,000 lbs. The machinery was in operation 105 days, and the farmers were paid an average of $4.16 per ton. Some of the beets ran as high as 20 per cent., and the average of nearly 16 is, we believe, one of the highest yet reported for any campaign. The soil in that vicinity is remarkably adapted to the crop, but, like the rest of the state, suffered severely from the unprecedented drouth of '98. For its second campaign, 1898, the Los Alamitos Sugar Company reports: "On account of the severe drouth we did not plant more than 1400 acres. Of this amount we got a stand of about 300 acres, from which we received 3000 tons of beets, which produced 6000 bags of sugar. Under usual normal conditions, we should have planted 7000 acres, and from this we should have received about 70,000 tons of beets, which would produce about 14,000,000 lbs of sugar, so you can see that this year's campaign was quite disastrous to the company. We have made contracts for 1899 to have 8000 acres planted; up to the present time (Dec. 6) have not had any rain, but there is plenty of time yet, and if it comes this month or in January we are sure to get a good crop." We believe the richest crop of beets on record was worked up at this mill. It was grown in Orange county, and averaged 27 per cent. sugar of 88 purity!

The Crockett Sugar Refining Company, with a capital of $2,000,000, has an enormous plant at Crockett, on San Francisco bay, with a capacity of 350 tons of cane and 1000 tons of beets per day. It was started to refine Hawaiian sugar, and during the interim to manufacture beet sugar. It is contracting for 10,000 acres of beets per year and is cultivating 1600 acres of beet land itself near the factory. It pays $4 per ton for beets testing 15 per cent. sugar, with 25c extra for each additional per cent. of sugar. It draws its supply of beets mainly from Contra Costa, Napa, Sonoma and Solano counties. It is in charge of experienced sugar people and there is every reason to expect its permanent success.

THE LATEST MODERN ENTERPRISE.

What is said to be the model beet sugar factory of the world is the new plant of the Pacific Sugar Company at the new town of Oxnard, near Hueneme, Ventura county, Cali-



A ROW OF CENTRIFUGALS AT THE OREGON SUGAR COMPANY'S MILL.

This glimpse of the interior, taken in connection with the other views of this property on Pages 163 and 168, gives a good idea of this large agricultural-manufacturing industry which this new crop is creating in northeastern Oregon.

fornia, some 3½ miles from the ocean. The illustrations on Pages II, III, VI, VII, also on Pages 147, 152 and 157, with their accompanying descriptions, convey a perfect idea of this beautiful establishment—the latest triumph of American experience and genius, and embodying all that the Oxnards and their experts have learned—or invented. Its boiler house, 195x55 ft, contains fourteen 250 h p boilers (3500 h p in all), capable of working under 200 lb steam pressure. The boilers and lime kilns are fired with crude oil brought from a pipe from the wells 35 miles distant, and standing in two tanks, each 85 ft in diameter, 30 ft high and with a capacity of 30,000 bbls each. Three large pumps are required to force water into storage tanks on top of building. The supply, 10,000,000 gallons daily, comes from flowing driven wells nearby, and the waste water runs into the ocean through a canal 6 to 8 ft wide and 4 to 6 ft deep. The beets are received at the factory on the elevated driveway of the beet sheds, 300x100 ft, and the wagons dumped (by electrically operated hoisting engines) into storage bins having a combined capacity of 5000 tons, from which the beets are floated, as used, by a stream of water running in a concrete conduit to the factory proper. The refrigerating plant makes 200 tons of ice daily. Twenty-eight pumps of large size are used to circulate the various juices about the factory. The plant occupies 100 acres. It will consume 1000 tons of beets daily in '99, and 10,000 acres have already been contracted for, but by 1900 the full capacity of 2000 tons daily will be reached. Over 20,000 acres will be needed to furnish the necessary supply of beets, say 250,000 tons, and at an average of $4 per ton a million dollars will be paid out by this mill alone for this new crop annually. The town of Oxnard, close at hand, bids fair to become a model city with every modern improvement.

All this section can be irrigated from the underground water shed, 130 to 250 ft below the surface, which is inexhaustible, being fed by the Sierra water shed and kept in by the ocean. Says Chief Engineer Bauer:

"A three-inch well can be sunk for a trifle, comparatively speaking. A hundred dollars will cover the cost, and its flow will irrigate many acres of this fine, moist soil. The farmers will be independent of rains then. The beet will hunt for water a long way down. Why, in Paris I saw a beet whose fine, silky tendrils had gone down 23 feet."

THE CULTURE OF BEETS FOR THE SPRECKELS FACTORY

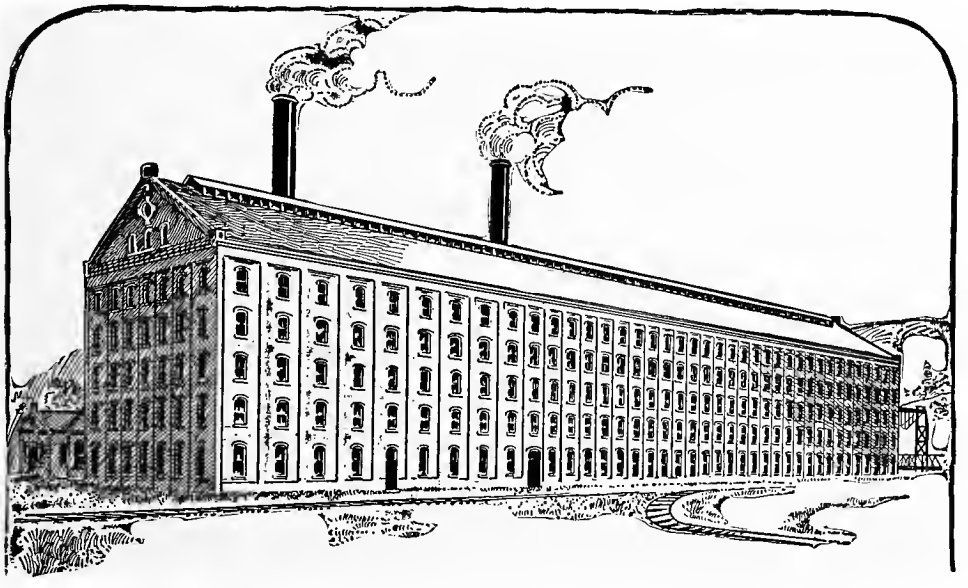
has been for years under the general charge of Mr. P. W. Morse, the agricultural superintendent. He prepared a very complete statement of the methods in vogue about Watsonville, from which we quote below. After emphasizing proper selection of soils and drainage from an excess of water in winter, Mr. Morse says:

"*Fertilization*—This is very little practiced in this valley. There is no pressing need for it just now, and land owners seem to prefer to utilize the resources now existing in their soil. Of course no land is inexhaustible, but soil that produces 20 tons of beets to the acre needs no fertilizer at present; and so long as the average yield of beets continues to increase, it is improbable that fertilizers will be used. I am pleased to observe that most of our farmers refuse to sell their beet tops, and thus save a great waste of valuable fertilizing material. Many of our farmers help to keep up the quality of their land by adopting systems of rotation.

"*Rotation*—And there is no doubt that, with a proper system of rotation and careful farming, the need of fertilization will not be apparent for many years. The beet appears to thrive better after certain plants than others. Here, beets yield most following potatoes and least following grain or hay. In those portions of the valley in which potatoes are not grown, corn, beans and alfalfa are the best crops to precede beets. The rotation giving best results here is: First year, potatoes, corn, beans or alfalfa; second year, beets; third year, barley; and is adopted by many farmers. It would be well if all farm-

ers would adopt some such system. To an eastern agriculturist such a rotation may appear to be a terrific strain upon land that is not fertilized, but so far the land shows no sign of deterioration.

"*Plowing*—In plowing and preparation of the soil for beets our farmers usually plow but once, and complete the preparation of the soil by working from the surface, without turning the soil over again. The reason for this is that, if land is re-plowed late, we may not get sufficient grain to work the surface fine enough for a seed bed for the beet seed. In late plowing there is also the chance of losing moisture that may not be regained, for, after March and even February, our spring rains cannot be relied upon. However, on badly drained land, or land foul with weeds, two plowings may be necessary. The plowing is deep, from 10 to 12 inches, and is performed by single or two-gang sulkies, drawn by four to six horses. Sub-soiling is not practiced, for, when the top 12



LARGEST BEET SUGAR FACTORY IN THE WORLD.

Near view of main building of new beet sugar mill at Spreckels, in the Salinas valley, Monterey Co., Cal., built by the Spreckels Sugar Co., Claus Spreckels president. This structure is 582x102 feet, five stories high, contains 3500 tons of steel and 4,000,000 brick, and with the accompanying buildings, machinery, etc., represents a cost of $2,500,000. The boiler house is 559x68 feet, 22 feet high, contains 24 enormous boilers and four economizers, and its steel smokestacks are 216 feet high, 13 feet in diameter and each weighs 1000 tons. The machine shop and carpenter shop is 559x40 feet, 22 feet high; oil house 20x32, warehouse 80x200, scale house 21x32, office 70x70. A reservoir for water holds 1,300,000 gallons, being 22 feet deep and 200x60 feet. There are also enormous silos for pulp, beet sheds, etc., the whole plant covering some 500 acres. A distant view of the factory, giving also an idea of the surrounding country, appears on Page 170, and on Page 181 is a different view showing boiler sheds, etc.

inches is plowed, the soil below is generally too wet to work, and sub-soiling would then do more harm than good. The cultivators used, I am glad to say, are all made by our local shops and are exceedingly well suited to the work. A couple of deep cultivatings, with a few harrowings and a rolling or dragging, are usually sufficient to complete the preparation of the soil. Our farmers have grown proficient in working the soil for beets, and

the percentage of failures on account of poor farming in this respect has been reduced to nothing. In former years it was formidable

"*Sowing* is done entirely with drills, sowing rows about 20 inches apart, seed being furnished by the beet factory, and in the performance of this somewhat delicate operation our farmers need no pointers from anybody, save in the matter of straight rows. Not enough attention is paid to drilling straight rows. It is rather surprising that our farmers, who are so straight in all other dealings, should be so crooked with their beet rows. A great help in late sowings, say after the middle of May, is the addition of V-shaped irons to the drill, which push aside the dry surface of the soil and enable the seed to be sown in moisture at a moderate depth. About ten pounds of seed are sown to the acre.

"*Thinning and Hoeing* are usually contracted together with topping and loading into the wagon at $1 per ton. There is a growing disposition on the part of farmers to hire labor by the day and look after the field work personally. In this way many farmers work their beets for as low as 70c per ton, and in one instance last year it was done for 55c per ton. The work was done better, and resulted in higher yield and increased profit to the farmer. The contract system is a makeshift, which worked well when labor was scarce, but should now be discarded, as labor is abundant and there is no good reason for retaining it.

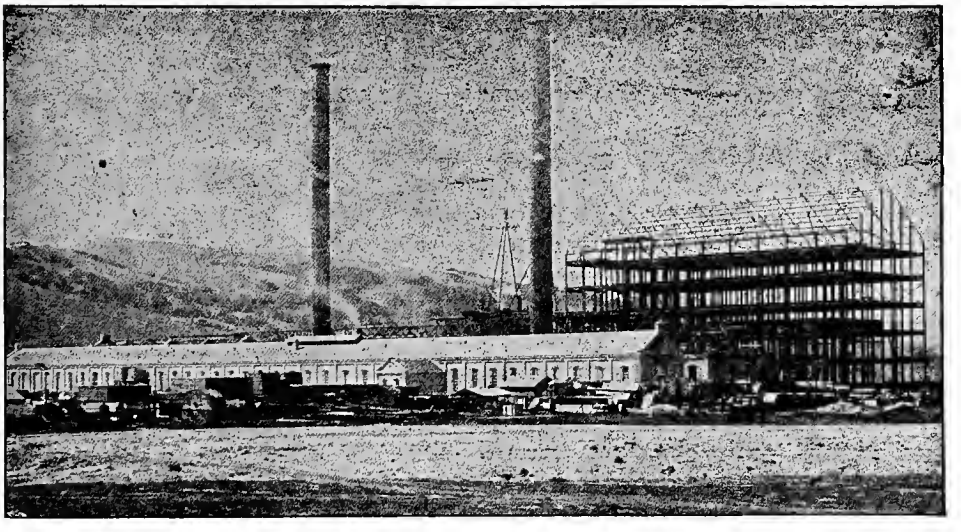
"Spacing and thinning beets are important operations and should be done under the eye of the farmer. Our beets are spaced from eight to 12 inches apart, according to quality of land, and should be all thinned before they are four inches high. Cultivating and weed cutting between the rows by horse power has greatly increased of late years, and saves an immensity of labor. Weed cutters are made to take two or four rows at a time, and are drawn by one or two horses. I noticed one four-row weed cutter last summer that worked twelve acres per day. These implements are made by the farmers themselves, and work well when the drill rows are straight. The rule for cultivating between rows in summer is to go as shallow as possible. Some few farmers practice hilling the soil against the beets, but I have never observed any benefit to come from it. After the leaves cover the ground all work on the field should cease until the beets are ripe.

"*Harvesting*—The farmer does not have to bother his head about the ripeness of his crop—the factory settles this point for him and orders the beets to be delivered as it may require them. After the beets are ordered in, comes the plowing out. The plow used for this purpose has two shares, which straddle the row to be plowed out. It is usually drawn by two horses, and gives the soil and beets between the shares a slight lift, sufficient to loosen the beets, which then remain standing in the soil, ready for the laborers to pull them out by the leaves. The beet plow must be strongly made and firmly braced. The top must be wide enough to allow the beet leaves to pass through without catching. If any dead beet leaves are lying on the ground, it is advisable to fix two rolling cutters in front of the plow, setting them so as to cut the ground to a depth of a couple of inches. The plowing will then be smoother and will be easier on both horses and men. Beet plowing is not well done unless every beet in the row is loosened without mutilation. It is in plowing out that the advantage of straight rows is particularly noticeable, as it is far easier to plow out a straight row than a crooked one. It is false economy to buy or keep an imperfect plow. Our local blacksmiths make splendid plows, and, if you tell them what you want, they will furnish an implement that will do perfect work. I have often seen farm hands breaking off the roots of beets with imperfect plows or careless plowing, and leaving two or three tons of such broken roots to the acre in the ground. The parts of roots left in the ground are an absolute loss to the farmer, and if harvested would pay for a new plow many times over in a season.

"*Topping* of the beet should be done with one stroke of a knife. Here 12-inch

butcher knives are used for the purpose. The crown and leaves, together with any portion of the beet growing above ground, should be cut off, leaving nothing but the root that has grown under ground to be taken to the factory. The old method of pulling and topping was to throw the beets into piles, top them and load into wagons with baskets. The newer and better way is to lay the beets in rows with heads one way. The topper then, after slicing off the heads, places the topped beets head down in rows, and with the tails in the air. They are then thrown into wagons by hand. It is a curious sight to see a field of beets thus standing in long rows in the reverse direction to which they grow. The advantages of the new method are that the beets are topped quicker, dry better in wet weather, are more easily loaded into wagons, and save the expense of baskets. The tops are also better distributed over the ground.

"*Hauling* beets has evolved a new form of wagon rack in this valley. It is in the shape of a wide, shallow box, raised high above the wheels, which it overhangs a few inches. It is not a thing of beauty, but it answers better than the old style of rack in that it is easier to load and unload, and a heavier load can be hauled with it. Such racks mounted on wide-tired gears weigh about 3200 pounds, and from 4 to 4½ tons can be hauled in them with four horses on a good road in dry weather. They are unsuitable for bad roads, as they are top heavy and liable to turn over. Good roads are indispensable to the beet farmer. No traffic is harder on roads, and this is due to the immense volume of it and to the heavy loads hauled."

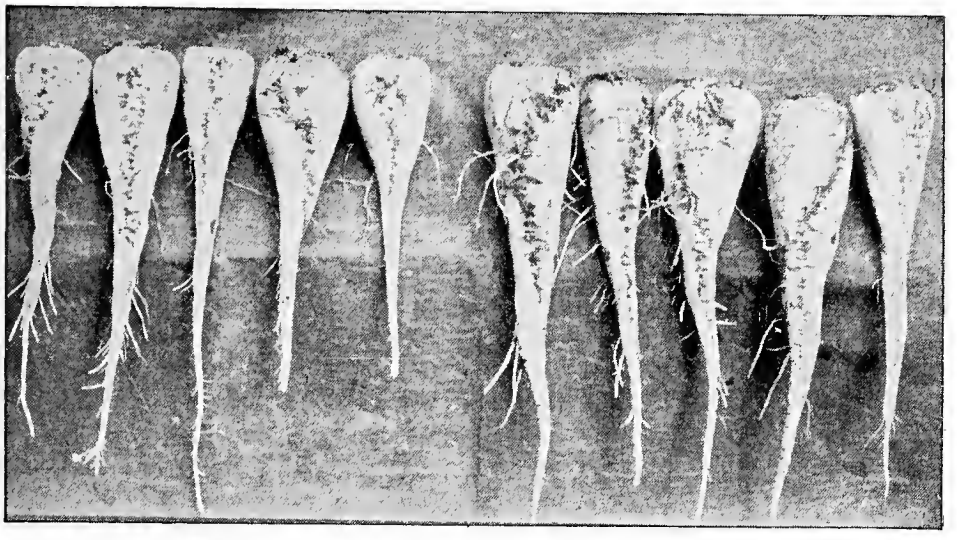


DISTANT VIEW OF THE MAMMOUTH SUGAR MILL.

Of the Spreckels Sugar Co., at Spreckels, in the Salinas valley, California, showing steel frame of main structure 582x102 feet, with boiler house 559x68 feet in foreground. See Pages 170 and 179 for other engravings and descriptions of this largest beet sugar factory in the world.

SUGAR CANE FIELDS ON A LOUISIANA PLANTATION.

This picture is taken from the top of the factory shown on a later page, and gives a fine idea of the magnitude of a Louisiana plantation. At the left, superintendent's house with negro quarters at the rear. In the center foreground, elevated bridge over railway tracks running to the cane fields. At right, long train loads of cane just cut and now ready to be run into the factory. At extreme right, background, quarters on a neighboring plantation, with miles of sugar as far as the eye can see in every direction.



KLEIN WANZLEBENER. KNAUER MANGOLD.

SOME TYPICAL OREGON SUGAR BEETS.

Containing 16 to 20 per cent. sugar, of 82 to 88 purity.

CHAPTER IV.

Recent Lessons in the Beet Sugar Industry.

COST OF GROWING BEETS.

More experience was added to the stock of information on this subject presented in Part Three, Chapter IV, but so few farmers keep accurate accounts that even now the data at hand is less than one could wish. We first give two statements prepared for this work and based on actual records kept by men who farm on business principles:

CALIFORNIA, SAN BENITO COUNTY—BY THOMAS FLINT, JR.

Until 1897 I had no personal experience in cultivating beets for sugar, all of my beet land, about 1200 acres, being leased to tenants. But in '97 I planted 16 acres to beets, and the course pursued was as follows: The land was plowed twice to a depth of 14 inches, cultivated and harrowed until thoroughly pulverized, and the seed sowed by drill in rows 20 inches apart. When the beets had grown to have two or three leaves, they were thinned in the rows to about eight inches apart. All weeds were, of course, destroyed during the season by means of cultivators and hoes. In September the beets were plowed out, topped and shipped. I was paid for 457,583 lbs. of dressed beets, at $4.50 per ton, $915.16, or $57.19 per acre gross. This was an average yield of 14.3 tons per acre,

making a net profit of a little over $1.50 per ton. Without charging for use of land, the expenses were:

	Per Acre	For 16 Acres
Plowing, harrowing, etc., at	$ 3.00	$ 48.00
Seed at 10c	1.23	19.65
Use of drill	.10	1.60
Sowing	.15	2.40
Cultivating	.70	11.20
Plowing out	1.00	16.00
Thinning, topping and loading	12.87	205.90
Freight to factory	13.83	221.37
Total expenses	$32.88	$526.12
Net profits	24.31	389.04
Total receipts	57.19	915.16

CALIFORNIA, ALAMEDA COUNTY, RANCHO DEL VALLE, BY E. K. LILIENTHAL.

The following fairly represents the average of several years' experience, but our yield in '97 was an average of 18 tons, instead of 15, as noted below. We get the work done by contract at the prices stated:

	Per acre	
Plowing in the fall, once	$2.00	
Plowing in the spring, twice	3.00	
Harrowing and smoothing	.50	
Seed, 10 lbs. at 12c, and 5 lbs. for reseeding	1.80	
Sowing once	.50	
Cultivating twice	1.00	—$ 8.80
Hoeing twice, thinning, topping and sacking (by contract at $1.25 per ton) for 15 tons		18.75
Hauling 15 tons, at 25c		3.75
Total cost, exclusive of use of land		$31.30
Net profits per acre		21.20
Total received for 15 tons, at $3.50		$52.50

When the yield is brought up to 18 to 23 tons per acre, and the price to $4 or $4.50 per ton, the margin of profit is, of course, largely increased. The '97 crop averaged over 16 per cent. sugar, which, at $3.50 per ton for 12 per cent., and 25c for each additional percentage, made a return of $4.50 per ton. Such a crop costs only the $8.80 per acre for preparatory work, as above, or a total (at contract prices) of $31.30 per acre, while at $4.50 per ton, the gross return is $81 per acre, and the net profit for use of land, $45.20 per acre. Hence we see how intensive culture more than doubles the profits per acre. Still better results are expected from steam plowing. See Page 189.

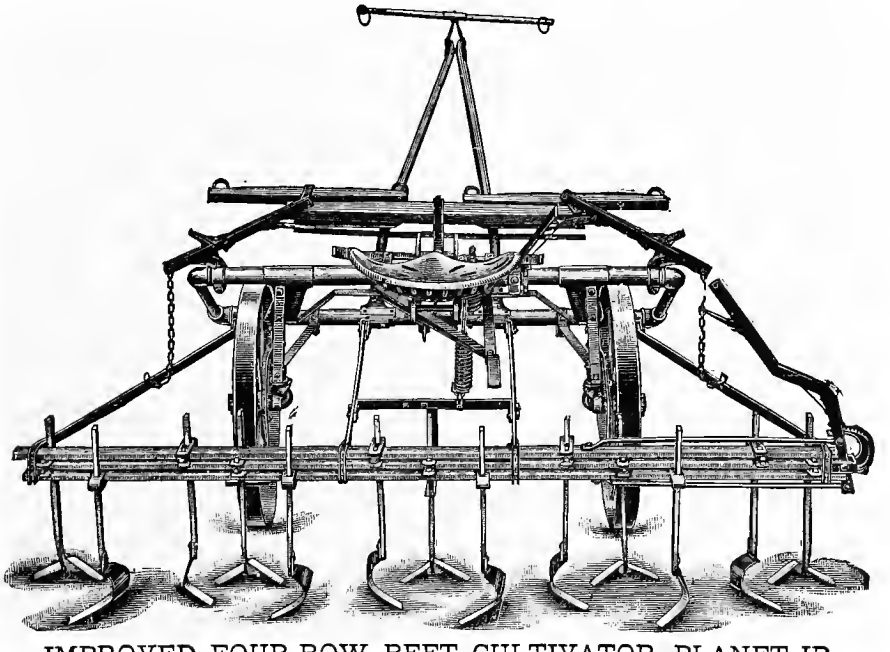
ANOTHER CALIFORNIA REPORT.

A remarkable statement is that furnished by Dethlefsen Bros., for their 1896 crop grown on 238 acres of rented land near San Juan, Cal. The harvest began Sept. 8, '96, was finished Jan. 19, '97, and averaged 18.7 tons per acre of dressed beets. The soil was a deep sandy loam, on the banks of the San Benito river, not subject to overflow, and had been pastured for seven years previously, but no manure or fertilizer was used. The season was ideal, rainfall 22 inches. Ten lbs. of seed were sown to each acre, and 50 acres had to be resown. A handsome saving was effected by working beets by day labor, instead of contracting them. The thinning, topping and loading of beets into wagons cost 55c per ton of beets, whereas the neighbors paid $1.05 per ton of beets to contract those oper-

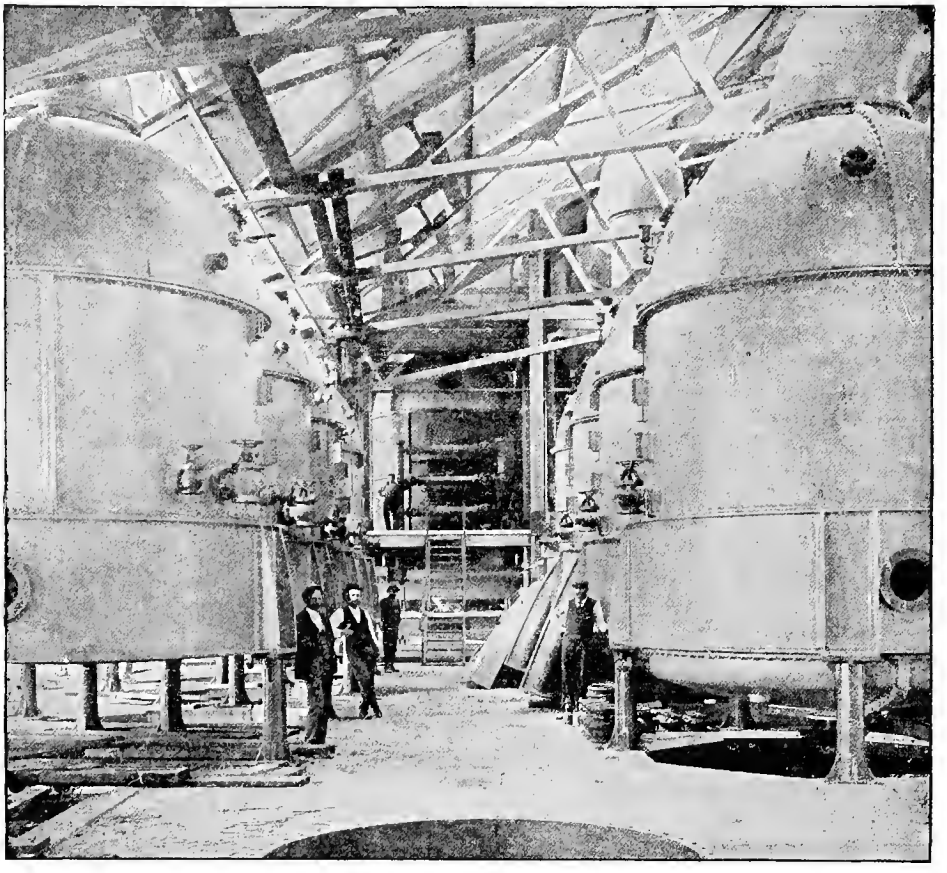
ations; the Dethlefsens here made a gain of $2,225.50. It should be stated that the profits to the Dethlefsens were greater than shown by the statement, as all of their own work is charged for at full rates of wages. This statement shows what can be done with everything most favorable:

EXPENSES OF THE CROP

	Total cost 238 acres	Cost per acre.	Cost per ton.
Rent of 238 acres at $7 per acre	$ 1,666.00	$ 7.00	$ .37
First plowing (Nov.)	340.00		
Second plowing (Feb.-March)	396.65		
Cultivating and harrowing	500.00	5.19	.28
Sowing—labor (May 1-June 3)	85.00		
—Use of drill	28.80	.49	.03
Seed—2830 lbs. at 10c	283.00	1.19	.06
Thinning—1100 days, at $1	100.00	4.62	.25
Cultivating and weed cutting—one man and two horses, 30 days, at $3	90.00	.38	.02
Plowing out—one man and team, 95 days, at $3	285.00	1.19	.06
Topping and loading into wagons—1,335.3 days, at $1.	1,335.30	5.61	.30
Hauling 3 miles to switch at 50c per ton	2,225.50	9.35	.50
Freight on railroad to factory	2,225.50	9.35	.50
Cost of knives and hoes	20.00	.09	
Interest	300.00	1.26	.07
Total expenses	$10,880.75	$45.72	$2.44
Income:			
4,451 tons of beets, at $4	$17,817.22	$74.86	$4.00
Sale of beet tops	200.00	.84	.04
Total income	$18,017.32	$75.70	$4.04
Net profit	$7,136.47	$29.98	$1.60



IMPROVED FOUR-ROW BEET CULTIVATOR, PLANET JR.



TWO BATTERIES OF QUADRUPLE-EFFECT EVAPORATORS.

At Pacific beet sugar factory, Oxnard, Cal. Each evaporator is 12 feet in diameter and 22 feet from floor to bottom of elbow, where the vapor pipes join, and these are 44 inches in diameter. One vacuum pan in extreme background.

IN MOUNTAIN AND PRAIRIE STATES.

Utah.—Statement of actual expenses on a crop raised for the Lehi factory by Mr. Granger, its superintendent, at $2.50 to $3 per day for man and team; men $1.25 to $1.50, boys 50c to $1 per day.

Mr. Granger says: "The very conservative estimate of only 13 tons per acre is used here merely to show what size crop can be made to pay well. By figuring on a yield of from 18 to 25 tons per acre—which is not at all extravagant—the possibilities of the crop may easily be recognized. A great number of farmers who raise beets for the Utah Sugar

Company make a net profit of from $30 to $50 per acre, after allowing themselves and family full wages for all work done on the crop." Mr. Granger's figures follow:

Fall plowing, 12 inches deep	$ 2.75
Pulverizing in spring	1.00
Rolling 25c, planting 35c	.60
Fifteen pounds of seed, at 18c	2.70
Rolling previous to thinning	.25
Cultivating previous to thinning	.50
Thinning	4.50
Hoeing after thinning	2.00
Furrowing out for irrigation twice, at 25c	.50
Irrigating twice, at 40c	.80
Cultivating after irrigation twice, at 50c	1.00
Plowing beets out at harvest time	1.50
Pulling beets after plow	2.00
Topping 13 tons, at 35c	4.55
Sacking and hauling 13 tons (3 miles), at 65c	8.45
Total expenses	$33.10
Yield, 13 tons, at $4 (this price paid at Lehi)	52.00
Net profit per acre	$18.90

Iowa.—Saylor's report gives the account of H. C. Graves & Son, who raised 41½ acres of beets at Council Bluffs, and shipped to the factory at Norfolk, Neb. They figure a shrinkage in weight in transit of 5.2 per cent., equal to $171.82, and paid in freight $896.71. These two items, amounting to $1,068.53, would have been saved if they could have delivered to a factory direct from the field. The crop averaged 15¾ tons per acre, average tare 8.83 per cent., average sugar content 14.4. At $5 a ton the actual profit was $31.98 per acre, or if for nearby delivery, $57.33 per acre, but at $4 per ton, $15.75 should be deducted from either profit.

	Total cost	Cost per acre
Preparing 41½ acres	$ 81.00	$ 1.95
Bunching and thinning plants	153.10	3.69
Replanting by hand	32.60	.78
Hoeing four times	102.70	2.50
Cultivating weekly for six weeks	137.85	3.30
Digging	84.10	2.05
Pulling and topping by hand	283.75	6.83
Hauling to cars	285.95	6.89
Seed	100.20	2.41
Machinery	38.75	.93
Total	$1,300.00	$31.33
Freight to Norfolk on 717.37 tons, at $1.25	896.71	21.60
Total cost of crop laid down at factory	$2,196.71	$52.93
$5 per ton for 654.1 net tons	3,270.50	78.80
Allowance received and for tops for cattle feed	229.67	5.53
Rebate to us on shrinkage in shipment	24.00	.59
Total receipts	$3,524.17	$84.92
Total expenses	2,196.71	52.93
Net profit for use of land	**$1,327.46**	**$31.98**

Herman Swatcher of Norfolk has grown beets every year since 1890, at a cost per acre varying from $28.60 to $31, and getting a yield of from 6 to 17 tons per acre. His profits per acre have ranged from $11.40 up to $37, except that on the '94 short crop there was a loss of $4 per acre. His '97 crop averaged 10 tons per acre, at a cost of $2.86 per ton, delivered at the factory, yielding a profit of $1.14 per ton, compared to from $1.58 to $2.18 in previous seasons. Nebraska experience is that, as a fair average for a series of years, beets at $4 a ton will pay all expenses of production, including use of land, taxes, etc., and a net profit over and above everything of fully a dollar a ton, or $10 to $15 an acre.

IN THE EAST.

New York—N. D. Lapham made a special study of methods and results of sugar beet culture in Wayne county, western New York, in 1898. A large number of farmers reported to him who had shipped their crop to the factory at Rome, N. Y. Their yields of dressed beets averaged 18 tons per acre, or from 16 and 17 tons in "flat" land and upland to over 21 tons on sandy loam. These beets mostly contained 14 to 17 per cent. sugar, all of over 80 purity, and netted $5 per ton at factory, including $1 state bounty. Mr. Lapham made an effort to ascertain the cost of growing beets, based on $3 per day for man and team, $2 for man and horse, and $1.25 for man. William Facer's figures ran up to $76.25 per acre for a crop that yielded 44,620 lbs. and sold for $111.24, making a net profit of $35 per acre. H. G. Hotchkiss had 13 acres raised on shares, kept a strict account, and found that the total cost was $503.75, or an average of $38.75. Allowing 35c per ton freight and deducting the total expenses from $85.38, the income derived per acre, for the crop of 17 tons, and there is a net gain of $46 per acre. At 15 tons, the net gain would have been $35.90, and at 12 tons $20.00. In all cases the tops and crowns are left on the farm for fodder. Mr. Lapham figured that corn yielding 80 bu per acre (worth at present 20c per bu. and stalks $5), would net less than $5 profit per acre, while the average potato crop pays less than $20 per acre profit. The average of over 18 tons of beets per acre gives a surplus in favor of the beet over potatoes of over $33 per acre.

Mr. Lapham concluded: "I wish to emphatically state that without one exception the Wayne county producer informs me that, considering prices of farm produce as they have been for many years, also taking into consideration the comparative labor necessary, there is nothing so profitable as the sugar beet for our farmers to raise." Mr. Facer's estimates, on the above basis, follow:

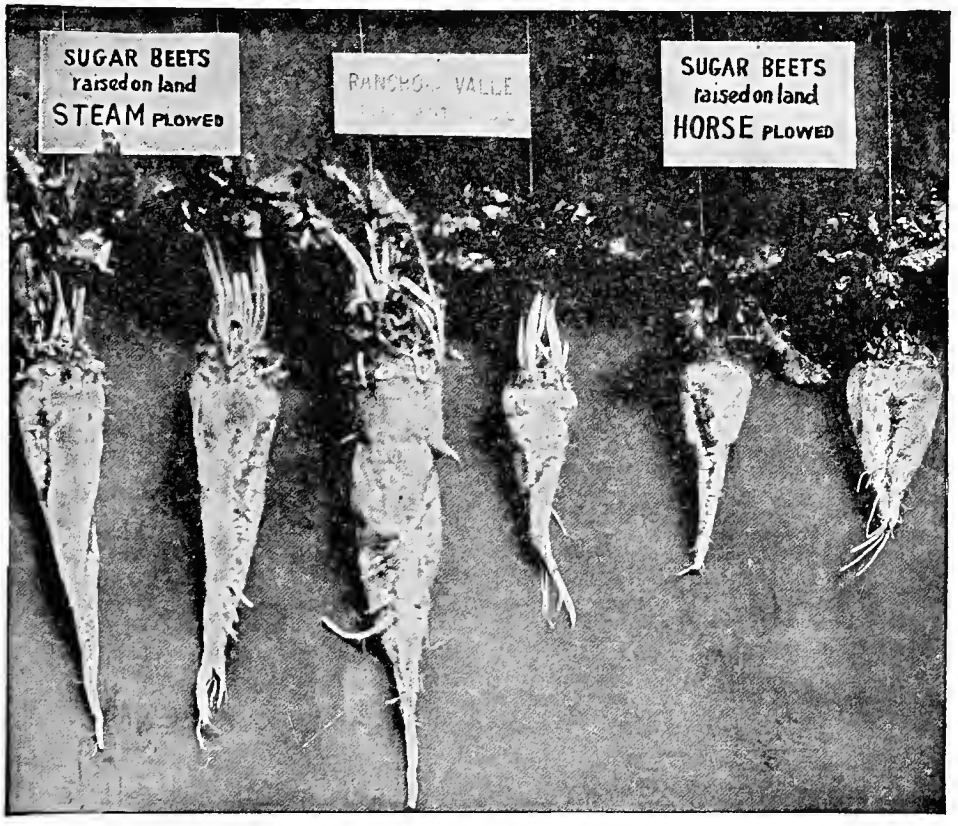
Drawing manure and fitting land	$ 7.00
Sowing seed	.50
First hoeing	5.00
Second hoeing	6.00
Third hoeing	5.00
Cultivating six times	6.00
Pulling and topping	15.00
Drawing to market 5 miles, 16 loads	24.00
Cost of shipping	7.75
Net for manure, use of land and profit	$76.25
Received for 22.3 tons per acre, at $5 per ton	$111.24

STEAM PLOWING FOR THE SUGAR BEET.

Steam plows have been in limited use for many years. Under certain conditions they do excellent work and are economical. One steam plow company guarantees its six-gang plow and 16 horse-power engine to turn over as much ground as six three-horse teams, provided the soil is firm enough to carry the engine, is free from stumps and

rocks, not too wet and has no grades or hill of more than one foot rise in 10 feet of distance; and good fuel and water are provided.

In the United States the level prairies of the west offer the best field for the use of steam on the farm, particularly those sections where most of the farm work is during the dry season, as in California, New Mexico and parts of Colorado, Nebraska, Kansas and Arizona. There the ground is sufficiently firm and dry to support an engine, and is also level and free from obstructions. On large wheat ranches steam plowing is popular, provided fuel is not too expensive and water is near at hand.



Steam plowed, 16 inches deep. Team plowed, eight inches deep.

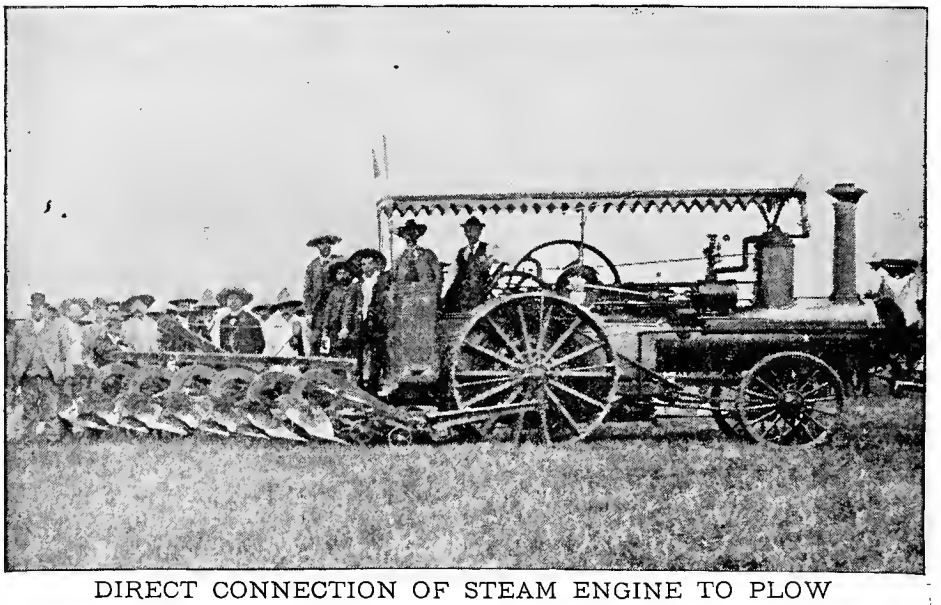
EFFECT OF DEEP PLOWING ON BEETS.

The beets are fair samples of the two crops. The deep-plowed land yielded ¼ to ⅓ more weight per acre, and the larger beets were richer in sugar, contrary to the usual rule.

The picture on Page 93 represents a steam plowing scene near Pleasanton, Alameda county, California. At each end of the field an engine is placed and the carriage to which the plow is attached is drawn back and forth by means of a wire cable 3000 feet long. Two engines of 12 horse-power each are required to do the work here. The plow is a four-gang reversible balance plow. This plan has several advantages. Softer or

looser ground can be plowed, as the engines do not move across the field while at work. Another method of plowing with a stationary traction engine is to run the cable entirely around the field, letting it turn the corners on strongly staked pulleys. A two-wheeled set of gangs is used and fastened onto the cable at any desired point. The engine may now stand still and draw the plow back and forth across the field by simply winding the cable upon the reversible drum attached to the underside of the boiler. The illustration of the Mexican plow herewith shows an engine coupled directly to the plows. Where conditions are favorable this method is used very satisfactorily. The two-engine system is used quite extensively in the Hawaiian Islands, there being thirty-three sets in use there now, each one of which will turn over about ten acres a day with a four-furrow plow.

Mr. E. K. Lilienthal, who has made a careful test of plowing at various depths and with teams and steam engines at the California farm alluded to, writes us in the highest terms of steam plowing for beets. It enabled him to plow to a depth of 16 inches, and the beets on such land were 25 to 33 1-3 per cent heavier than on soil plowed by



DIRECT CONNECTION OF STEAM ENGINE TO PLOW

teams. The importance of deep plowing is obvious, and he has yet to find an implement that equals the steam tackle illustrated on Page 93. Under this system, beets that weighed four pounds each ran high in sugar and were acceptable at the factory.

Mr. Lilienthal adds: "I have plowed over 500 acres this fall with this steam tackle, and could go 18 or 20 inches deep as well as 16, if it were advisable. In former years I endeavored to fall-plow with horses, getting uneven results, but have always been convinced of the necessity of steam plowing, and after seven years' experience with it, I am for it every time. The land is treated in the spring exactly as though it had been horse-plowed in the fall, but the rows are placed 16 inches apart on this steam-plowed land, instead of 20 as by the old method. We use 12 lbs of seed only, as we are not obliged to reseed, since the deep cultivation holds the moisture and insures sprouting of seed. Under

these improved methods and with an ordinary amount of rainfall, we expect over 20 tons per acre on each and every acre seeded. Our experience in the unprecedentedly dry season of '98 shows that this is a very conservative estimate for deep plowing and thorough cultivation."

Of course many soils are of such a nature that too deep plowing, or turning up of the subsoil, does more harm than good. In such cases, subsoiling beneath the surface plowing will accomplish the desired result.

A CAUTION TO THE INEXPERIENCED FARMER.

He is the one who usually thinks he knows most about raising sugar beets. If he is a westerner, he starts out to raise 100 or 200 acres of beets before he has learned how to grow one acre. The result is failure and disgust. We find that the man who has had the most experience in growing beets is the one who takes the fewest risks, who realizes how much even he has to learn, who does everything thoroughly and who is usually well satisfied with the result. Charles F. Saylor, who made a special inquiry on this point for the United States department of agriculture, truly says in his report (Page 178, document 396, H. R., 55th Congress, 2d session):

"We found, as a rule, that the farmers who were raising sugar beets for the first time were going more upon their own experience and knowledge of growing field crops than they were upon the directions given them by the department and experiment stations. They seemed to think that these directions were superfluous, calling for work that was difficult, and requiring the planting and the cultivation of the beets in a manner that was totally foreign to their experience and therefore wrong. They failed to appreciate the fact that they were dealing with a new feature in farming, or one which they had hitherto neglected, and in modifying the directions they were violating some fundamental principles on which the success of the sugar beet for factory purposes depends. They seemed to look upon the experiment of growing the sugar beet as a thing in which there was no remuneration, and therefore a thing on which they could not afford to waste much time. In considering these experiments in growing sugar beets, the general public may get an indication of the first great difficulty the industry in this country is to meet and master, and that is the education of the farmer to the necessities of the cultivation required."

IRRIGATING THE SUGAR BEET.

This subject is so new, and to many sections so important, that to the facts stated on Page 96, the following summary should be added of Mr. Saylor's inquiry for the United States department of agriculture (1898):

"Experience has demonstrated that irrigation should be held off as long as possible and applied as little as possible. Water should not be applied by irrigation until the natural supply has failed, and even then the grower must be careful not to apply too much. Too much is as disastrous as not enough. We have learned by talking with those experienced in the application of water by irrigation of the tendency of the land to dry out quickly after being irrigated, and of the ground to become packed, so that cultivation must follow as soon as practicable after irrigation.

"It has been noticed that the beet has a tendency to send down its taproot deep into the soil, and especially is this true in the earlier stages, if the necessities of the case demand it in order to procure moisture, and this is to be desired. If water is applied too lavishly in the beginning, this tendency of the beet is arrested, and it shows a disposition to rely on an artificial supply of water rather than seek its own, and we have thus interfered with a natural tendency that is desirable in the growth and maturity of the beet. The effect will be, under these circumstances, that the taproot will divide and the beet will become bunchy and sprangle out, assuming a form entirely undesirable.

"The beet may show a tendency to slightly droop its leaves and to become lighter in color, but this does not indicate that irrigation is needed. If the beet recovers its vigor in the evening, it is a sufficient indication that it is getting along all right. When it comes to suffer from drouth, the tendency will be to droop and get darker in color, and it will

not apparently recover vigor with the approach of the cool of evening. This is the time to consider the question of applying irrigation.

"We have noticed two methods of irrigating beets, either of which seems to accomplish the work successfully. One of them is to plant the beets in rows, say, from 18 to 20 inches apart, and then when it is desirable to turn on the water, a small furrow is run between every other row by the use of an implement made for this purpose. The water is then turned on and allowed to trickle down these furrows. This causes the water to pass down on one side of every row in the field, and leaves the space between every other row that is not so furrowed. When it becomes necessary to apply water again, a furrow is made between the rows not furrowed before, the former furrow having been leveled up by cultivation.

"The second plan is to plant the first two rows the usual width apart, say, from 14 to 20 inches, and then the next space between the other two rows will be considerably wider, say, up to 26 inches apart. This wider space is entirely for the purpose of having an irrigating furrow, which is made in a similar maner to the one described above, the wider space occurring between every couplet of rows. In either case, water can be held in these furrows by throwing a shovelful or two of dirt into the furrow in front of the water until the ground becomes thoroughly saturated around the beets, and then the obstruction is removed, and continued down the furrow. Of course the supply furrows are conducted along the higher places and the cross furrows arranged in such a way that all parts of the field are reached. This simply suggests that the grower, in the application of water by irrigation, must thoroughly understand the science of economically distributing the water in the field, which is a question too broad to be entered into here, but by experience the farmer becomes more or less adept.

"In regions where the beets are started in the spring with moisture from rainfall, it is the aim of the grower to produce his crop with four or five irrigations of the beets. After they begin to ripen, all irrigation must cease, for the same reason that it is not desirable to have a rainfall after the beets are ripe."

MORE ABOUT BEET PULP.

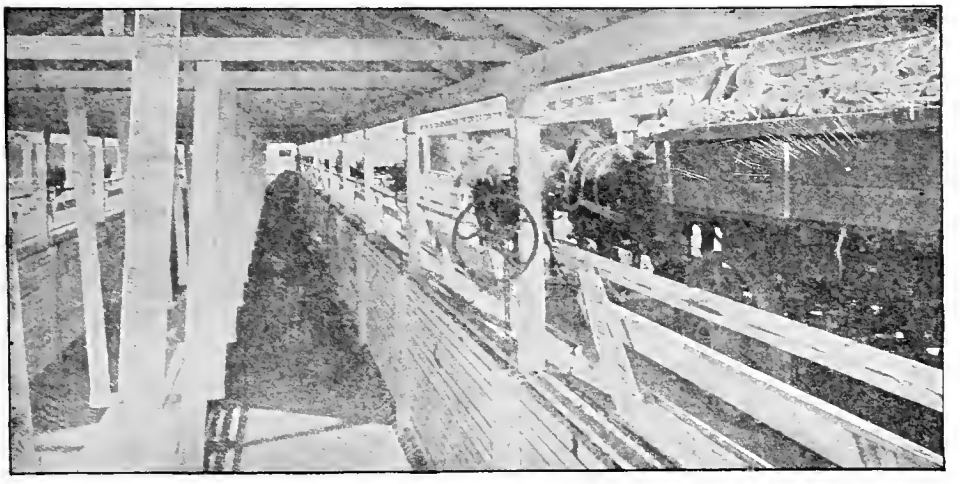
American farmers are slowly but surely learning to appreciate the great value of beet pulp for stock feeding. Two years have added much to the stock of experience cited on Pages 108-112. Mr. Saylor found by inquiring of many who had had extensive experience in feeding pulp to cattle general agreement on these points: Pulp feeding aids the work of digestion; the same amount of feed adds more fat and flesh to the animal; an animal will be prepared for the market six weeks earlier, showing a wonderful economy of time and feed. He obtained the following detailed report from John Reimers of the Grand Island (Neb.) Live Stock and Commission Company, who has had long experience in feeding pulp on a large scale:

"I consider it a valuable food in connection with grain and other feed, as it is a great digestive food and appetizer. It has some fattening qualities, but I do not depend on it for that purpose, but mainly to digest the other foods.

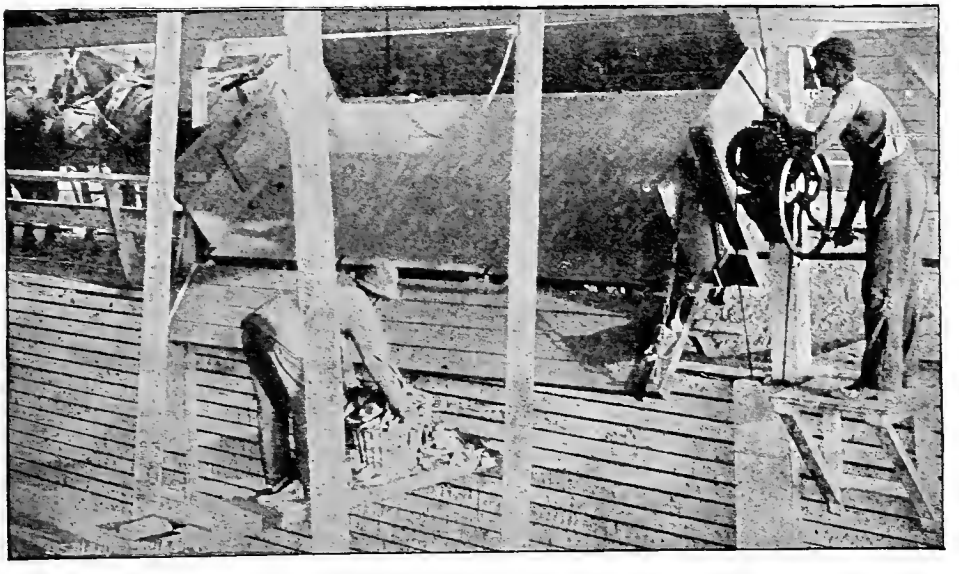
"When I begin feeding cattle, I use for the first few days from 20 to 25 lbs. of pulp per head daily, with hay and a little grain or meal mixed with it. Then increase gradually to 40 or 50 lbs. per head. I have also tried 80 to 90 lbs. per head, but am positive that this is of disadvantage in fattening cattle, as they eat less grain and meal. Too much pulp is inclined to be loosening. Cattle can be put on full feed of grain much quicker with pulp, as it helps to digest this food and lessens the danger of overfeeding or getting the cattle stalled and foundered.

"After feeding from 90 to 100 days, I would advise going back gradually to 20 and 25 lbs. of pulp per day, and increasing the grain food, of which each feeder must judge for himself the amount his cattle can stand. Cattle eat as much grain per day with the limited amount of pulp as they do without it, but this food in connection produces flesh more rapidly, and thereby shortens the feeding season.

"I find it better to feed ground feed with pulp rather than whole grain, but the pulp is beneficial with any kind of food. I have found, when feeding pulp with the same amount of roughness and grain that generally is required in the west to fatten cattle, that I could put on an extra gain of from 50 to 75 lbs. per head, or I can make the same amount of gain as I obtain in the ordinary way of feeding in three-fourths of the time,



READY TO UNLOAD BEETS AT FACTORY DUMP.



HOW THE UNLOADING IS DONE.

Showing also how a sample basket of beets is taken to be tested for sugar content. At the Los Alamitos sugar works.

and consequently save considerable grain and roughness. The pulp-fed cattle will sell as readily as any other, as they dress and ship as well, even for export, which I myself have tried.

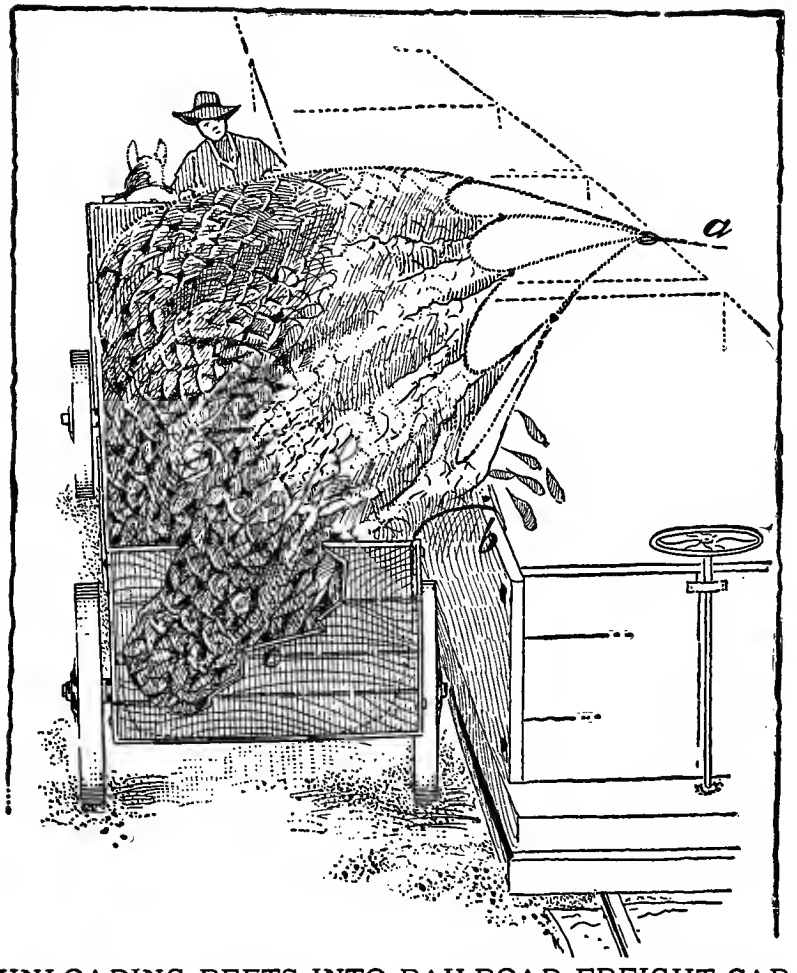
"I consider the pulp also a great food for stock cattle, if mixed with roughness, as it is a wholesome food and makes young stock thrive and grow. Cattle will eat poor and damaged roughness, which they otherwise would not touch, if mixed with pulp. I have fed fresh pulp direct from the factory and also so-called sour pulp after it had been in silo. The pulp will keep in silo for years, but it will shrink some. The result is virtually the same in feeding either kind of pulp, and I consider them equally good, only that sometimes it takes three or four days before all the cattle learn to eat the sour pulp, while they will all eat fresh pulp readily the first day."

For milch cows, this pulp is an A 1 feed, and is prized accordingly, especially by dairymen in New York state. P. W. Morse, agricultural superintendent of the Spreckels sugar mills, wrote in January, 1899: "The demand for beet pulp, which has already risen to the capacity of our Watsonville (Cal.) mill, was intensified the past year by the scarcity of feed, and a fancy price could have been obtained for this product, if we had taken advantage of the situation. This was not done, but pulp was supplied at 10c per 2000 lbs. F. O. B. wagons or cars at mill, and parceled out among beet raisers. The value of beet pulp for fodder is well appreciated here and far exceeds the nominal price we charge. We furnish the pulp to beet raisers in proportion to the number of acres of beets planted, and this privilege to buy pulp at a nominal price is sought after, and is a factor in obtaining beet contracts. We are content with the greater common interest promoted between mill and farmer and a constantly appreciating market for the pulp."

In California, farmers keep pulp in cheap silos, made in or above ground. For the latter, a slatted structure like a corncrib is often used, which allows the water to drain out. The mass will thus shrink one-half in weight during six months. "Four months after such storing of pulp, the silo was opened, and it was found to be a compact mass, free from odor and without the taste of potash. Mr. White stables his cows at night, and the pulp is fed to them at that time—70 lbs. to the animal—and they clean it up. They take to it with eagerness. Mr. White says that from the same number of cows he is making twice as much butter as at this time last year, when the cows were well fed on other feed. The increase in milk production since his cows commenced feeding on siloed pulp has also astonished Mr. White. When properly handled, the beet pulp will prove to be as rich stock feed here as it has been demonstrated to be in Europe; but it must be siloed. Age and fermentation improve it. Mr. White hauled his pulp about eight miles; he estimates that it cost him when ready for feeding (and he figured cost of hauling, loss by shrinkage, etc.) not to exceed $1.40 per siloed ton—and he is confident that no other feed approaching that price can equal the milk and butter showing of siloed pulp feed."

In Utah and New Mexico, certain parties are coining fortunes by fattening vast flocks of sheep for market on alfalfa and beet pulp. The sheep get two lbs. of hay and from three to four lbs. of pulp daily. The pulp gives the best results in both cattle and sheep feeding in Utah after being fermented in the silos for 30 days. At Eddy, N. M., the sheep ate from four to eight lbs. of pulp and one lb. of hay per head daily. At Shelton, Neb., where 25,000 lambs were fed on pulp from Norfolk, they consumed three lbs. per head per day. Hake Bros. of Grand Island fed 20,000 lambs about four lbs. of pulp and 1 to 1½ lbs. of corn meal per head per day mixed, besides what hay they want. The sheep take to the pulp readily.

Dried beet pulp from beet sugar factories has been used to some extent as a cattle food by Swedish farmers and there found very satisfactory. In some cases the molasses which naturally accumulates at the beet sugar factory is mixed with the pulp and the whole is dried. Practically all the pulp made in European beet sugar mills is utilized for



UNLOADING BEETS INTO RAILROAD FREIGHT CAR.

A strong net is placed in the bottom of the wagon or cart, the ends of the net lapping over the two sides. The beets when dug are thrown by hand into the wagon, which is then driven to the freight car. Here the net on the side next the car is attached to the car, as shown above at *b*. The two ends of the net and the further side of the net are fastened together and made fast at *a*. Here a chain is attached, leading over the car to where a team of horses are hitched to a whiffletree. The team starts up and thus dumps the whole wagon load of beets into the car. The whole job takes but a few minutes and saves all hand work. Indeed, the beets are not touched by hand or by hand tools after being thrown into the wagon from the field where they grew.

feed. The weight of the pulp is about half as much as the weight of the beets that go into the factory. In other words, a ton of pulp can be depended upon for every two tons of beets sliced, after the water is partly drained out.

STORING BEET TOPS.

Beet tops make excellent feed, but some growers are so situated that the best use they can make of them is to plow under the tops and necks. Mr. Ware, in the *Sugar Beet*, describes the French method of siloing beet tops. It is done as soon after cutting as possible, not later than two weeks after. Pits about six feet deep and six feet wide and of any desired length are dug on a slight slant in dry soil, filled with beet tops and carefully tramped down. The leaf piles continue up three feet above ground and are then covered with 2½ feet of earth, straw not being suitable. Fermentation soon follows and the leaves settle or shrink about one-third. Sometimes the leaves are simply piled in the field and covered thickly with earth. It may require some days before the cattle will eat this beet leaf silage, but by adding salt, the taste is soon acquired. About as much of this silage is given per head daily as would be of corn silage. See also Page 110.

THE PROPER MANNER OF TAKING SAMPLES

from a patch of sugar beets is thus described in the *Sugar Trade Journal* by J. G. Hamilton of the Oxnard Company. The sugar beet matures in 4 to 4½ months from the date of planting, but we generally commence sampling the fields about a month previous to their maturity, that we may ascertain from week to week how the beets are ripening. The correct way of getting a fair average of a field is to walk through the field diagonally, taking up about six beets, say one beet from every tenth row. Of course this would depend entirely on how large the field was. If you want to select the ripest beets, always pull those where the leaves are yellowish in color, and never those having new leaves sprouting. The beet having green foliage shows that it is not ripe, and the beet having new leaves growing indicates second growth, where the sugar content would be found to be poor. Never select beets from the outside rows, they probably being larger and not as mature as those more in the center of the field. Where a beet is pulled that has fingers or false roots growing on it, it should be thrown aside and another beet selected. After the samples are taken, the top of the beet should be cut off at the bottom of the lowest leaf, and it requires about five to six beets to get sufficient juice to make a proper polariscope test.

THE PRODUCTION OF SUGAR BEET SEED

in this country is receiving constantly increased attention. The work of the Lehi factory in selecting the highest grade mother beets and raising its own seed has already resulted in a material increase in the sugar content. California seedsmen are giving the matter careful attention. The United States department of agriculture and various experiment stations are also working on the problem. It is only a question of time before this country produces all the beet seed it will consume. As the cost for seed is from $1 to $2 per acre, and as upward of 2,000,000 acres of beets will eventually be grown in this country every year to supply the home market with sugar, the extent of the sugar beet seed specialty may at once be realized. Fortunately, the only obstacle heretofore in the way of raising our own sugar beet seed has been removed by the publication of Lewis S. Ware's new book, "Sugar Beet Seed," by the Orange Judd Company. This book is an elaborate study of the methods followed by the most successful beet seed producers of Europe, and a careful reading of its pages will be a great help to everyone interested in this phase of the industry.

The factory usually furnishes seed to the farmers in order to insure best results. That plan avoids such instances as this: "Fraud in sugar beet seed has already begun A.

AN OREGON FIELD OF SUGAR BEETS.

This crop made nearly 14 tons per acre, in spite of 1898 being a poor season and the first year beets were grown on this land or by this farmer. They averaged 16½ per cent. sugar of 83 purity.

J. Ogran of Waupaca, Wis., paid a tree peddler $1 per lb. for sugar beet seed guaranteed to be of exceptionally rich quality. Samples of beets grown from this seed contained only 8 to 10 per cent. sugar in the juice with a purity of 68 to 71. These are some of the poorest analyses made at the Wisconsin station that year, most of the other samples running from 12 to 18 per cent. This shows conclusively the importance of seed of the best varieties."

The importance of good seed in sugar beet cultivation cannot be too strongly emphasized. The United States consul at Magdeburg writes that because of the absolute superiority of German beet seed, not less than 100,000 bags of it were bought by Frenchmen last year. It sells in Saxony at 8 and 10c per lb., which is a moderate price, considering that it takes at least four years to get the seed into market. Second-class seed is sold there at 5 and 6c and is mainly shipped to Russia and the United States. This inferior seed produces a beet that will yield 1 to 2 per cent. less net sugar in the factory. Thus, if it takes 55 tons of seed to produce 50,000 tons of beets, the consul figures that the saving on first cost of cheap seed would be some $3000, but the beets therefore would yield $30,000 worth less sugar. In other words, the best seed would earn $27,000 more for the factory than poor seed under like conditions.

BOUNTIES TO THE SUGAR INDUSTRY.

The enormous and rapid development of the beet sugar industry in Europe is partly due tc the way in which it has been stimulated by direct subsidies from the gov-

ernment. In addition to extraordinarily high protection against foreign competition by means of very liberal duties on imported sugar, direct export bounties are still paid in Europe as follows: France pays a bounty of 30 to 39c per 100 lbs. on all domestic sugar exported; Germany, 27 to 38c; Austro-Hungary, 27 to 42c. A direct bounty on production of 45 to 51c per 100 lbs. is paid in the Netherlands, and Bulgaria pays the extraordinary bounty of 4c per lb. for 10 years.

In the United States, the bounty of 2c per lb. provided for in the McKinley tariff of 1890 was offset by the admission of imported raw sugars free of duty. The system of direct bounties paid by the respective states has been tried in this country with some success. The present encouraging condition of the industry in Utah was brought about in the first place by the state bounty of 1c per lb., which helped the Lehi factory over its first season or two. Nebraska would have had no beet sugar factory, probably, but for the bounty equal to $1 per ton on beets grown in the state, which was paid for the first few years. The law provided a bounty equal to about 1c per lb. on sugar, conditional upon the farmers being paid at least $5 per ton for beets.

In New York, the bounty paid by the state also helped to insure a speedy beginning of the industry. It became a law May 18, 1897, and appropriated $25,000 to be apportioned to sugar manufacturers pro rata, provided that none received more than 1c per lb., and provided that not less than $5 per ton was paid for beets grown in the state by others than the manufacturer of the sugar. The law also authorized the state commissioner of agriculture to spend 10 per cent. of the appropriation in practical and scientific experiments in growing sugar beets. It provides for the inspection and sampling of beets. In 1898, $50,000 was appropriated for this bounty.

In New Jersey, the legislature of 1898 passed a similar law, but it was vetoed by the governor, on the ground that experiments did not indicate sufficient grounds for believing that the industry could be made a practical success in that state.

In Washington, the legislature of 1897 passed a law offering a bounty of 1c per lb. on sugar made within the state containing 90 per cent. of crystallized sugar, produced from beets for which not less than $4 per ton had been paid. This bounty goes to any factory that is completed prior to November 1, '99, and shall continue for three years.

Michigan, by act of March 26, '97, offers a bounty of 1c per lb. for 90 per cent. crystallized sugar made from beets for which at least $4 per ton of 2000 lbs. has been paid, for all beets containing 12 per cent. of sugar, and a proportionate amount shall be paid for beets containing a greater or less per cent. of sugar. The law carefully provides for inspection, weighing, etc., and appropriates $10,000 for paying the bounty, with the proviso that any deficit be paid from the general fund not otherwise appropriated, to which is added a final section, as follows:

Sec. 8. Every person, firm or corporation that shall erect and have in operation in this state a factory for the manufacture of sugar from beets, with a capacity of 2000 lbs. of sugar or upwards per day while this act is in force, shall be entitled to receive from the state the sum of 1c per lb. for all sugar manufactured from beets at such factory, for a period of at least seven years from the taking effect of this act.

Under the latter clause there is no limit to the amount the state may be called upon to pay, and as the Bay City factory during its first campaign of '98 made some 7,500,000 lbs. of sugar, it draws $75,000 bounty from the state. This law has led to the placing of contracts for the erection of at least two other factories in Michigan as we write, so that '99 will see at least three factories operating in that state that will pay for beets upward of $500,000 a year.

Exemption from taxation for all property invested in the beet sugar industry (except special assessments for local improvements in cities and villages) is offered by

Wisconsin for five years from 1897. Wyoming exempts from all taxation for ten years.

A number of state legislatures will now be asked to furnish a bounty of some form for a few years. In most cases they will probably accede to this request. It will do much to insure a supply of beets the first year or two, or until farmers generally have learned to grow the crop to advantage. In all such cases the law should be so worded that a bounty of 1c per lb. should in effect go to the producer, so that, instead of $4 per ton, he may get $5 per ton for beets. States may well afford this encouragement to their farmers for a few years, because one or two successful factories in a state will mean the

HAND CULTIVATION OF SUGAR BEETS.

This shows the Planet Jr. double wheel hoe in a field of beets, leaving the crop clean and thoroughly worked, and the ground level, using the cultivator teeth only. From a photograph taken in central New York

establishment of others. Moreover, such a state bounty will be some offset to the uncertainties of congressional action. It will not be necessary for any state to offer a bounty for a long term of years, nor do we approve of such, but under present circumstances, some special local encouragement for a few years, under proper safeguards, will prove to be a good policy for all concerned.

A FEDERAL BOUNTY.

Speaking of the possibility of protection to the domestic sugar industry being threatened by the admission of sugars from the tropics duty free, Mr. Ware says in *The Sugar Beet* for October, 1898:

There is only one remaining solution for promoting the beet sugar industry in this country, and that is a bounty on home production and exportation. European experi-

ence shows that not only does a well-arranged bounty force the manufacturer to improve his processes, but encourages the production of more sugar than the local demand needs for its consumption. The bounty as it hitherto existed in this country was upon sugar extracted; the effort of manufacturers, then, was to secure that bounty, regardless of careful scientific processes. The good that could follow was and will always be temporary. On the other hand, if we admit that an average factory can extract 10 lbs. of sugar from 100 lbs. of beets, let a bounty be paid to those manufacturers who exceed that amount. To accomplish this, superior beets and machinery are needed, higher prices would be paid to farmers, who will thus receive a great encouragement for the production of roots having a high sugar percentage. Let manufacturers receive from the United States government one cent a pound for all sugar exported; let all new and existing factories pay a tax into the treasury in amounts proportional to their annual production. This method would prevent the building of patched-up so-called beet sugar factories and would encourage the erection of beet sugar plants only after the latest and most improved designs. Ample capital could be secured for their working; the government tax would be a trifle as compared with the profits to the manufacturer and farmer. With Cuban, Porto Rican and Philippine sugars in competition, the American beet sugar industry could hold its own. The monopolists of these islands will cause, sooner or later, a rise in the price of sugar per pound; home beet sugar will derive the benefit just as it does in California. Another question remains, should not the United States government collect an export tax on sugar leaving the islands now under our flag? This would be a means of forcing each state to pay the war expenses incurred by its annexation.

NEW STANDARD OF PAYMENT.

Beets are usually paid for by two plans: (1) At a straight price, say $4 per ton, for all that test 12 per cent. sugar of 80 purity or above; 2, at a graded price, say $3.50 per ton for 12 per cent. and 80 purity, and 25c more for each additional 1 per cent. of sugar or 25c less for each reduction of 1 per cent. sugar. By the latter plan, beets containing 16 per cent. sugar would net $4.50 per ton, against only $4 by the first plan.

The graded price is an effort to pay for beets according to their quality. But it is not a strictly accurate method, as it is based only upon the quantity of sugar. The scientifically exact plan would be to grade the price upon both quantity and quality. A beet of 16 per cent. sugar of 90 purity is worth considerably more than one of 16 per cent. and 80, but by the grading now in vogue they would be paid for at the same price.

Prof. P. G. Sukey, chemist at the University of Michigan, calls our attention to Stamner's method of meeting this difficulty, as outlined in Prof. Sukey's article in the Louisiana Planter, Dec. 11, '97. He would base contracts for beets on a standard of 10, called the "number of value." Thus a beet containing 12.75 per cent. sugar and a purity of 78.75, multiplied together and divided by 100, would be the standard, for which he proposes that $3.80 should be paid. For every additional number of value 20c per ton more should be paid, and for every number of value below 10 should be deducted 20c per ton. We figure that the new method would compare with the present graded or straight prices as follows:

Sugar X purity gives number of value	——Price per ton of beets——		
	New method	Graded method	Straight method
11x75 — 8	$3.40	$3.25	$4.00
12x80 — 9	3.60	3.50	4.00
12.75x78.75—10	3.80	3.50	4.00
13.25x80 —10	3.80	3.50	4.00
13.25x85 —11	4.00	3.50	4.00
14x80 —11	4.00	4.00	4.00
14x86 —12	4.20	4.00	4.00
15x80 —12	4.20	4.25	4.00
15x87 —13	4.40	4.25	4.00
16.25x85 —14	4.60	4.50	4.00

Stamner's number of value is fully as simple as the present graded method and more accurate. Either plan of grading encourages the production of rich beets. Stamner's method is to beets what the Babcock test is to cream. But lots of farmers are suspicious of either test, and prefer a straight price, regardless of quality. That is why it is adhered to at Lehi and at the Spreckels factories, though these beets are almost always well above 12 and 80, so that there is little risk to the factory and the bother of testing is avoided. The other factories in this country grade the price, but not all on exactly the same basis.

THE UNITED STATES DEPARTMENT OF AGRICULTURE

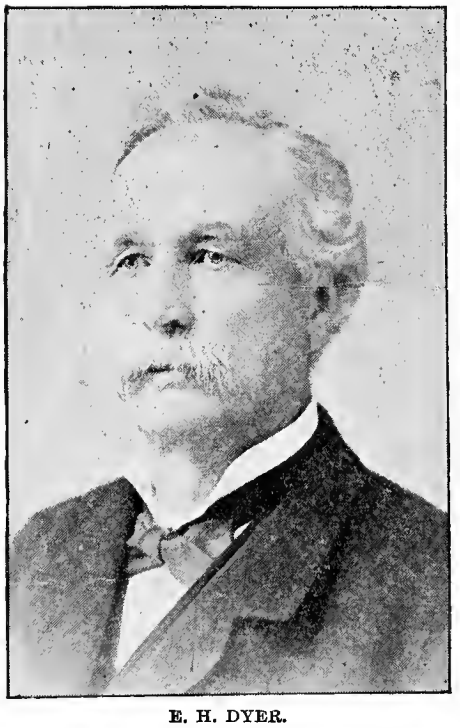
published in the spring of 1898, a bulletin giving a comprehensive account of all its work with the sugar beet up to that time. Writing in January, '99, Dr. H. W. Wiley, the chemist, says that the analytical data obtained from beets grown in '98 corroborated entirely the results of the season of '97. "The best results have been from beets grown in New York, Michigan, northern Indiana, northern Ohio, Wisconsin and Minnesota. I do not think that a final study of our data will cause any change, either in the area mapped out as probably suitable for the industry nor in the distribution within that area of favorable localities."

NEW POINTS FROM THE SOUTH.

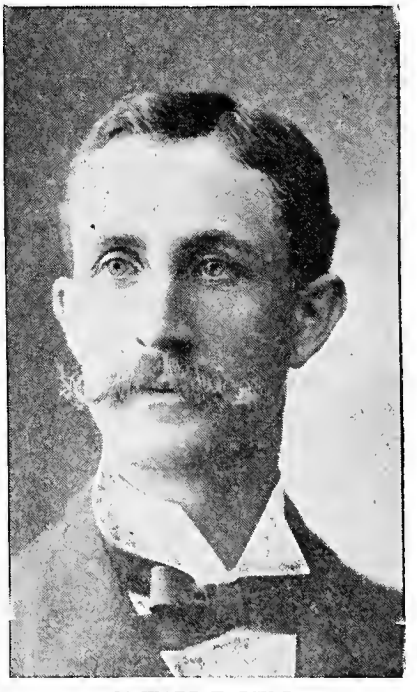
Florida is becoming very much interested in sugar cane. Analyses made at the Florida experiment station of the crop grown during 1898 showed from 20 to 29 per cent. sucrose. The average of the station's crop when harvested Dec. 5 was 25 per cent. The station has demonstrated that with Spanish moss the crude juice of the sugar cane can be nicely clarified and the sugar made therefrom given a light brown color. It can be further whitened by refining with clay that has been slightly blued by the introduction of a little powdered ultramarine. The effect is an apparently white sugar, really no purer or better than the yellow article, but which meets the public demand and sells for a better price. These methods of making a colored product of sugar and syrup on the farm with comparatively rude and expensive methods are attracting great attention and causing a large increase in the cultivation of sugar cane in Florida.

THINNING AND CLEANING BEETS, LA GRANDE, OREGON.

CLAUS SPRECKELS.



E. H. DYER.



EDWARD F. DYER.

APPENDIX.

(a) Some Leaders in Creating This New Industry.

A REMARKABLE MAN AND HIS WONDERFUL CAREER.

Claus Spreckels was born in Hanover, the young German arriving at New York in 1830. He became the proprietor of a small retail grocery store. With the discovery of gold in California, he closed his business in New York and went to the Pacific coast—not as a prospector or a miner, but as a merchant. He continued as a grocer, maintaining the reputation he had gained in New York as a keen business man, but achieving no special prominence. After 25 years of fairly prosperous business, he began outside investments. They proved most profitable and he soon sought larger fields. He became known as a speculator in sugar, and studying this trade carefully, he found that it was then dependent upon a supply from outside sources and was extremely costly on the Pacific coast.

In deciding upon a location for the production of sugar, he found a Paradise in the Pacific ocean—the Hawaiian Islands—and here Mr. Spreckels settled. Sugar could be raised more cheaply here than in the United States, and could be shipped to the Pacific coast cheaper than from the sugar producing regions of the Union. Mr. Spreckels was always prominent among the white population, and devoted his time largely to securing sugar plantations. Just how he obtained control of the entire sugar output of the Sandwich Islands will probably never be known. He did, however, and long before 1885 was known as the sugar king of the Sandwich Islands. His power was far greater than that of the native ruling monarch. All the sugar plantations were under his personal control, and all the product was refined at his plants and later sent to the United States.

It was during this period that he accumulated his enormous fortune which enabled him to successfully contend against the sugar trust. When that gigantic monopoly undertook to drive him out of the sugar business on the coast, he not only successfully contended against it, but, erecting a big refinery at Philadelphia, brought the trust to terms in its very home. The trust bought out his eastern business at his own price and agreed to leave his western business alone. He made several millions in this deal.

Mr. Spreckels early saw the immense possibilities of the beet sugar industry in the United States. He was so impressed therewith that he gradually sold out his Hawaiian interests, as the success of the beet sugar industry was demonstrated at Watsonville, Cal. The eleven years' record of that enterprise is stated on Page 170, and was such as to warrant Mr. Spreckels in building the largest beet sugar mill in the world. It is located in the heart of the rich Salinas valley, California, and the new city of Spreckels is growing up about it. A full description of this mammoth plant is a feature of the present book (see Pages VIII, 170, 179, 181). This vast enterprise is a fitting monument to the man, who is one of the typical "makers of the west."

Mr. Spreckels married early in life. He was always known as a man of domestic tastes, preferring his own home to the attractions of society. He is, however, well known in the social world, both east and west. His favorite amusement is the friendly game of

cards. He has five children, four sons and one daughter, all of whom are well educated and have traveled much. The son, John D. Spreckels, has long been his father's right-hand man in his large business enterprises, aided by another son, A. B. Spreckels.

Claus Spreckels is of medium hight, strongly built, and despite his many years is tremendously active and capable of much work. About the only indication of age is the increasing whiteness of his hair. After all the years that he has lived in America, he still speaks with a decided German accent. His success in accumulating a fortune has certainly been phenomenal. He began at the lowest round of the ladder, and by patience, industry, sobriety, devotion to business and good judgment, has become one of the wealthiest men in the United States. He is one of the keenest of men. A few years ago, the financial world was agog over the "electric" method in sugar refining. Its promoters got a vast sum out of the eastern refiners and then went to 'Frisco to "take in" Mr. Spreckels. He listened patiently to the description of their marvelous process, and when they had finished only asked, "What becomes of the dirt!" The promoters had failed to think of that point, and were utterly disconcerted. The thing was a fake.

THE BEET SUGAR PIONEER.

For 30 years E. H. Dyer has been almost continuously engaged in the manufacture of beet sugar in the United States, and now, at the ripe age of 78, in robust health and sturdy mental vigor, is about to see the realization of his most cherished hopes in the development of the industry to such an extent as to supply the American market with American sugar. He was the pioneer in the commercial beet sugar industry, and upon the results of his work the industry has been placed on a sound industrial basis, and only requires the proposed favorable national policy for its gigantic development. One has only to read a brief sketch of his life to realize the service E. H. Dyer and his boys have done to our beloved country.

Mr Dyer erected the first beet sugar factory on the Pacific coast at Alvarado, California, in 1870. After running four years, it proved a failure, through the incompetency of the technical management—two Germans who had operated in a small and unsuccessful way at Fond du Lac, Wis. They claimed that the location was not suitable, organized a new company and moved the outfit to Soquel, Santa Cruz county, where, after a few years of heavy losses, it was abandoned. Mr. Dyer, who had purchased the land and buildings of the old plant at Alvarado, still had confidence in the business under good management. But it was difficult, in the face of so many failures, to induce capitalists to invest with him, and it was not until 1879 that the machinery was returned to Alvarado and the factory started by the Standard Sugar Refining Company, O. F. Griffin president and E. H. Dyer superintendent. This was a success from the start and paid satisfactory dividends for eight years, when a boiler explosion completely wrecked the factory. The profits of the first four campaigns were $104,081, being the first sugar made in the United States from beets at a profit.

Mr Dyer became convinced that the complete success of the industry in this country could not be obtained as long as we depended upon foreign countries for machinery, so he and his son, Edward F., and H. P. Dyer, a mechanical engineer and draftsman, spent many months in German sugarhouses and machine shops. In 1888 they entirely rebuilt the plant at Alvarado, which has run successfully ever since and has recently been increased to a capacity of 800 tons per day. The Dyers then built the model beet sugarhouse at Lehi, Utah, and have since constructed other successful factories. The young men referred to planned all their machinery and had it made in this country, with such success as to greatly economize both labor and fuel, enabling them to extract all the available sugar from the beet at a much less cost than ever before.

(b) Factory Contracts with Beet Growers.

The various forms of agreement used in the United States are covered by the following selections:

UTAH SUGAR COMPANY'S CONTRACT.

This agreement made and entered into this —— day of —— 1898, between the Utah Sugar Company (a corporation) the first party, and —— of Lehi, second party, Witnesseth: That the first party agrees to purchase from second party any and all beets he may produce (from seed furnished by the first party at the rate of 15c per lb.) on the —— acres of land hereby agreed upon, that do not weigh over 3½ lbs. each and contain not less than 12 per cent. sugar in the beet and that have a purity co-efficient of not less than 80 per cent., paying him therefor at the rate of $4.25 per ton, delivered and piled in a proper manner under first party's direction and unloaded at the Utah Sugar Company's factory at Lehi at cost of second party in first-class condition, with the tops closely and squarely cut off at the base of the last or bottom leaf. The beets so delivered shall reach all the requirements of this agreement, and not contain any diseased, frozen, damaged, or improperly topped beets, nor any beet that weighs over 3½ lbs., otherwise the entire load so being delivered may be rejected. The dirt weighed with the beets shall be tared and deducted from the gross weight by the first party in its customary manner, and shall be conclusive. Payment shall be made on or about the 15th day of each month for beets delivered the previous month. Said beets to be delivered only when ordered by the first party up to Oct. 15, 1898, after which time and until Nov. 30, 1898, second party may deliver beets as fast as he may desire, if the said beets reach the required standard. To ascertain the quality of the beets, the first party shall at various times before and including Nov. 30, 1898, and also at times of delivery, sample and polarize in the usual manner, the results of which shall be conclusive. If said beets have not reached the required standard by Nov. 1st, 1898, tested in the usual and customary manner, and if after that time and up to time of the delivery attain it, then the first party may deduct 50c per ton from the contract price. After the 30th of November, 1898, it shall be optional with the first party whether or not it accepts any beets that have not been delivered. The second party hereby agrees to plant, cultivate and harvest, in a husbandmanlike manner —— acres of sugar beets on the land agreed hereon and protect them from the frost and sun while being harvested and delivered, and deliver them at the times, places, and in the manner set forth in this contract for the sum of four dollars and twenty-five cents per ton, to be paid as above set forth. This contract is not transferable.

CONTRACTS UNDER STATE BOUNTY LAWS, NEW YORK.

This Agreement made and entered into by and between —— of —— in the county of ——, state of New York, party of the first part, and FIRST NEW YORK BEET SUGAR COMPANY, of Rome, N. Y., party of the second part: Witnesseth, That the party of the first part, for a valuable consideration to him in hand paid, the receipt whereof is hereby acknowledged, agrees to and with the party of the second part, that he will properly sow —— acres of the part of his farm that will produce the best sugar beets, with seed to be furnished free by party of the second part, and to properly care for and cultivate the crop raised thereon for and during the season of 1898, and to deliver the same properly topped when so ordered on board boat or car for factory at Rome, N Y.

The party of the second part, in consideration of the premises, hereby covenants and agrees to and with the said party of the first part, First, to furnish the seed free sufficient to sow ——— acres and to deliver the same at ———; Second, to pay to him for said beets to be delivered as aforesaid, the sum of Five Dollars, cash, per ton of 2000 lbs., on or before February, 1899, at the office of said Company at Rome, N. Y., according to the weight of same as ascertained at the factory of the said party of the second part at Rome, N. Y., by the official weigher designated by the State Commissioner of Agriculture. Beets to be loaded at ——. This contract is not assignable or transferable.

MICHIGAN SUGAR COMPANY'S CONTRACT WITH FARMER.

Contract made this —— day of —— by and between —— party of the first part, and the Michigan Sugar Company, party of the second part, Witnesseth, as follows: The party of the first part, for and in consideration of One Dollar ($1) in hand paid by the

party of the second part, does hereby agree with the said Michigan Sugar Company, to plant, cultivate and harvest, to the best of his ability, in a husbandlike manner,—— acres of sugar beets, on the following described land,—— by said first party; ——in section——, township——, range——, in the county of ——, Michigan. That he will plant, cultivate and harvest the said beets from seed furnished by the Michigan Sugar Company, and when more than one kind is furnished, will keep the different kinds separate, in the sowing and harvesting. He will plow the soil deep and work it well before seeding, and so far as the Sugar Company or its agent shall give directions, he will, to the best of his ability, follow them in said seeding and harvesting. That he will sow about 18 lbs. of seed to the acre.

He will harvest and deliver to the factory of said Sugar Company the beets so raised by him at, and as directed by said Company or its agent, as to time, quantity and manner of delivering. And when directed by said Sugar Company to deliver the beets by or before a certain time, he will put forth every reasonable effort to do so. In harvesting said beets, he will cut off the tops clean and square at the base thereof, so that no part of the stem shall be left thereon.

He will purchase all seed from which such beets are to be raised from the said Michigan Sugar Company, and will not accept any seed from other parties from which beets are to be ralsed for said company. That all seeds for the planting of beets under this contract shall be paid for at the rate of 15c per lb. at Bay City, and amount due for same shall be deducted from the first payment for beets delivered. That he will not dispose of any of the seed to other persons. That in case beets do not come up uniformly from the first time planting, he will as early as practicable re-plant the same. That he will thin out, weed out and cultivate the beets as early in the season as they are ready to be cultivated and thinned, giving prompt attention, and bestowing all necessary labor thereon in due time and season, to the end that the best possible results may be obtained. That he will sell or deliver no beets to any other person, firm, corporation or factory, but that all beets raised of a suitable quality shall be delivered to the Michigan Sugar Company as directed by it.

The Michigan Sugar Company, party of the second part, agrees with said —— party of the first part, that it will furnish beet seed to said party of the first part, of a quality of the best that can be obtained by it for producing beets, so that if the said plants are well cultivated as herein specified, they will produce beets of a quality suitable for making sugar. That it will charge said party of the first part no more than 15c per lb. for seed. That it will for its own interest have an agent from time to time visit the field or fields of said first party as, to it, shall seem best, to the end that such work shall be done in a proper manner, with the purpose in view that the best quality of beets shall be produced by said first party. It is hereby further agreed by and between the parties that said Michigan Sugar Company reserves the right to give notice to the party of the first part to deliver said beets when and as it requires them, and that said first party hereby agrees that all beets not delivered by him to said company, prior to Nov. 1st of the year in which this contract is made, shall be placed in silo, until they are wanted by the company.

It is further agreed between the parties hereto that beets testing 12 per cent, to sugar and of a co-efficient purity of 80 per cent. shall be accepted by said company not later than January 15th next, and paid for at $4 per ton, delivered in the company's storage sheds at its factory; and a sum proportionate to that amount shall be paid for beets containing a greater or less amount of sugar and co-efficient purity; provided that when the beets are delivered in carload lots and it is necessary that they be put into the storage sheds, the company shall unload them and charge therefor only the actual cost thereof. That in case the party of the first part shall fail to fulfill the requirements of this contract in growing, cultivating and delivering of said beets, said party of the second part may put on a force of men and teams as the case may require, and carry out this contract as herein agreed; but this latter clause shall in no way absolve said first party from his obligations to said company.

It is further agreed that when and as the beets are delivered to the storing sheds of said party of the second part, they shall be examined, tested and weighed by the state weighman and inspector and in accordance with the state law now in force in this state, known as an "Act to provide for the encouragement of the manufacture of beet sugar and other purposes," approved March 26th, 1897. And when so tested and weighed and the amount of each wagon or carload, as the case may be, has been determined as to per cent. of sugar, co-efficient purity, and quantity of such beets, and certificate furnished

thereof by said weighman and inspector, showing the quantity and quality thereof, settlement thereon shall be had and payment made on the 15th of the month following, for deliveries of beets during the previous month.

Said party of the first part agrees that so far as he is able to do, after receiving instructions from the agent of said company and of the state inspector, that he will assort out all beets that are not of a quality herein specified, and retain them for his own use on the farm. The said company shall not be required to take any beets that have been frozen or rotted or are otherwise defective so as to render them unfit for making sugar.

Said party of the first part further agrees to notify said company as early as Aug. 15th, in the year in which he is raising beets, how many acres of beets he will have to harvest the coming fall.

When this contract has been signed and a copy thereof delivered to each party, no agent of said company has any authority to change or alter the terms or conditions thereof.

WHERE THERE IS NO STATE BOUNTY. LOS ALAMITOS CONTRACT.

This Agreement, made this —— day of —— 189 ——, between the Los Alamitos Sugar Company of the county of Orange, California, party of the first part, and —— party of the second part, Witnesseth: That for and in consideration of the covenants hereinafter contained, it is hereby mutually agreed between the parties hereto as follows, to-wit:

[*a*] That the party of the first part shall furnish, for the purposes hereinafter stated, that certain tract of land situated in the county of Orange, state of California, and described as follows: ——

[*b*] That for the current cropping season, beginning January 1st, 1898, and ending January 1st, 1899, the party of the second part shall, in the manner hereinafter specified, plant or cause to be planted, the above described land to sugar beets, the seed to be furnished by the party of the first part at 12c per lb., which amount said party of the second part agrees to pay therefor.

[*c*] That the time and method of preparing the ground, planting the seed, cultivating, weeding, thinning, gathering and delivering said beets shall be in accordance with the instructions to be received from time to time by the party of the second part, from the party of the first part. The seed shall be sown in quantities to be designated by the party of the first part, say between 12 and 18 lbs. to the acre. And the land shall, whenever it is deemed necessary by the party of the first part, be subsoiled to a depth of not less than 12 inches. The beets shall be preserved from sun and rain, and shall be delivered as hereinafter specified, as free from dirt as circumstances will admit, clean and in good condition, with tops closely and squarely cut off at the base of the last or bottom leaves, according to instructions, especially as to times and methods, received from time to time from the party of the first part. All manure which may accumulate on the premises, including the leaves cut from beets as gathered, shall be distributed and plowed under by the party of the second part as a fertilizer. When directed by the party of the first part, the party of the second part is to commence and proceed with the harvesting and gathering of the crop, and continue delivery thereof at the Los Alamitos Sugar Factory; the date of delivery and amount to be delivered each day shall be determined by the party of the first part.

[*d*] That the party of the second part shall not permit weeds to grow among the beets, and shall keep weeds cut down to the center of the road or avenues on or adjacent to the said land.

[*e*] That whenever the party of the second part shall fail or neglect to promptly and properly comply with the requirements of this contract, or with the verbal or written instructions of the party of the first part, or its agent, in respect to the plowing of said land, or the planting, thinning, weeding, cultivating, harvesting or delivering of the beets grown thereon, or the keeping of said roads and avenues clear of weeds as aforesaid, it is agreed that the party of the first part shall have the right, if it so elects, to enter upon said lands without notice, and to do and perform any of the said acts or things so neglected by the party of the second part, and the cost and expense thereof shall be a charge against the said second party's share of the said crop. The party of the first part shall be the sole judge as to the fact of such neglect by the party of the second part. Beets not properly cut and trimmed, or with dirt clinging to them, will be cleaned and cut and the tare deducted from the weight of beets, and it is mutually agreed that the party of the second part shall pay to the party of the first part —— cents per ton of

beets to cover laboratory, tare taking, weighing and other expenses for the purpose of protecting the interests of the parties hereto, and said amount shall be deducted from the amounts due said second party for beets delivered.

[*f*] That in case the Los Alamitos Sugar Factory is damaged by fire, or otherwise in such a way that it will be impossible to repair same in time to work the crop of beets, then this contract shall, at the option of the first party, become null and void; and in the event of its exercising such option, the party of the first part agrees either to pay to the party of the second part, $11.25 per acre for every acre contracted for and actually planted with such beet seed at the time of the disaster, or in the event of such disaster, and also at the request of the party of the first part the party of the second part shall deliver said beets at the railroad depot at said factory site in such quantity as the party of the first part shall require, but not to exceed —— tons per day, at the same prices and on the same terms as hereinafter specified. The party of the first part may exercise either alternative as above specified, and the fulfilment of the same shall be binding upon the part of the second party upon notice by the party of the first part.

For all beets delivered at the factory according to the conditions named above, the party of the first part agrees to pay as follows—$3.50 per ton for beets containing 12 per cent. of sugar to the weight of the beet, with a purity co-efficient of 80; and an additional 25c per ton for each and every per cent. of sugar contained above 12 per cent., as determined by test made in the laboratory of the party of the first part. In determining the percentage of sugar, any fraction of 1 per cent. under one-half of 1 per cent. shall not be counted, but any fraction of 1 per cent. not less than one-half of 1 per cent. shall not be counted as 1 per cent. The party of the first part reserves the right to reject very large beets, diseased beets, or those parts of beets grown above the ground not fit to be manufactured into sugar, or beets below 12 per cent., or whose co-efficient purity is less than 80.

The party of the first part shall be entitled to the one-fourth part of the crop raised on the land above described, as rental thereof, the same to be delivered at the factory. Five per cent. of the amount coming to the party of the second part for his share of the said crop, shall be retained by the party of the first part, until the said land has been thoroughly cleaned of all weeds and beets after harvest.

It is further expressly agreed, that possession of the entire crop to be raised on said lands, shall remain in the party of the first part, until the said rent has been paid, and until all amounts which may be or may become due from the party of the second part to the party of the first part under the terms of this lease, whether it be for seed, or laboratory expenses, or the expenses mentioned in clause "*e*" of this contract, or on account of any other covenant herein contained, have been fully paid; and that any attempt by the party of the second part to sell. transfer, convey or mortgage said crop or his interest therein prior to the delivery thereof as herein agreed, shall entitle the party of the first part to at once take the same into his own hands and proceed to deal therewith in all respects, the same as if the property had been entirely sown and planted by the party of the first part and this contract had never been made.

The party of the first part will advance to the party of the second part from time to time, during the beet thinning season, such sums as may be recommended by the field superintendent of the party of the first part, for the purpose of thinning or weeding the said crop, and not to exceed —— per acre, for which the party of the second part shall give a note or notes, payable out of the first deliveries of beets made by him to the factory, and bearing interest at the rate of ——per cent. per annum, said notes to be secured by a chattel mortgage on the interest of said second party in said crop, the same to be executed and delivered at the time of making such advances. The party of the second part agrees to plant all the seed furnished by the party of the first part, on the acreage contracted for, as described above, and dispose of it in no other way.

Payments will be made on the 15th of every month for beets delivered during the previous month, and all moneys due by the party of the second part to the party of the first part shall be deducted from the first payments. Notice should be given to the party of the first part at once if anything detrimental occurs to the crop after the seeds are in the ground.

THE SPRECKELS CONTRACTS

with farmers who supply beets to the factories at Watsonville or Salinas, Cal.

A—FOR FARMERS WHO RAISE THE CROP ON THEIR OWN LAND.

This Agreement, made and entered into between the Spreckels Sugar Company, a corporation duly incorporated under the laws of the state of California, party of the

first part, and —— of —— county, California, party of the second part, Witnesseth: That for and in consideration of the covenants hereinafter contained on the part of the party of the first part, that the party of the second part shall and will plant, cultivate, harvest and deliver to said party of the first part, at its sugar works, at Watsonville, Santa Cruz county, California, or at Spreckels, Monterey county, California, at option of party of the first part during the current planting and harvesting season of A. D. 1898, sugar beets of the seed to be furnished for that purpose by the said party of the first part, to the extent of —— acres of land in —— county, the particular tract to be cultivated being now selected and agreed upon between the parties thereto.

The party of the first part hereby agrees to furnish the necessary beet seed at 10c per lb., which alone shall be employed in raising said crop; the cost of said seed and any advances made by the party of the first part on account of beets raised under this contract to be deducted from the price of the beets first delivered under this contract, until the party of the first part shall be reimbursed. It is also agreed that the party of the second part shall cultivate up and re-sow to beets any of aforesaid land upon which the beets do not come up to the satisfaction of the party of the first part.

When directed by the party of the first part, the said party of the second part shall commence and proceed with the harvesting and gathering of the crop and to continue the delivery thereof in the beet bins at the Watsonville or at the Spreckels sugar works, whichever may be designated by the party of the first part, clean and in good condition, and with the tops closely and squarely cut off at the base or bottom of the green or sunburned part, until the said crop shall be exhausted. The date of delivery and the amount to be delivered each day shall be determined by the party of the first part, and shall be increased or diminished to meet the requirements of its factories as it may direct.

Beets weighing above 5 lbs., or grown mostly above ground, or defective and unfit to be manufactured into sugar, will not be received. From all beets delivered the party of the first part shall have the right to deduct 5 per cent. for earth and sunburned tops; but if a trial washing shall show more than 5 per cent. of earth and sunburned tops, all amount in excess of 5 per cent. shall also be deducted. The party of the second part further agrees that he will keep beets protected from sun and frost after removal of said beets from the ground.

Should the party of the second part neglect or refuse to comply with the above conditions, the party of the first part has the right, at its option, to cancel this contract. It is further agreed that the party of the first part or its agents shall at all times have access to the tract of land cultivated under this contract by the party of the second part.

In Consideration Whereof, the party of the first part agrees to pay four dollars ($4) in lawful money of the United States, per ton, for all beets cultivated and delivered in accordance with the terms of this agreement. Beets shall be paid for at the office of the Spreckels Sugar Company, at Watsonville, on the fifteenth day of the next following month after the beets are delivered.

B—FOR GROWING BEETS UNDER CONTRACT.

This Agreement, made and entered into between —— hereinafter called first party, and —— hereinafter called second party, Witnesseth: That for and in consideration of the covenants hereinafter contained, on the part of first party, to thin out, hoe, clean, at the different times and in the manner prescribed by first party, to thin out, hoe, clean, cultivate, pull, top and load into wagons provided by first party, sugar beets upon —— acres, more or less, to be planted by first party the present season, in —— valley —— county, California, the particular tract now being selected and agreed upon between both parties. Second party further agrees: (1) To commence to thin and hoe beets as soon as they shall develop two leaves and provide sufficient men to complete thinning and hoeing before beets shall be four inches high. (2) To thin out beets —— inches apart in the rows, and to leave not more than one beet to each —— inches of row, to hoe with hand or horse hoes the entire soil between the rows directly after beets are thinned, and to carefully pull or hoe out all weeds growing thereafter until beets are harvested. (3) When directed by first party to pull, shake free from the adhering earth, top and load beets into wagons; beets to be topped cleanly and squarely with one blow of the knife at base of bottom or last leaves, and any portion of the beet grown above ground to be also cut off. All beets above 5 lbs. in weight to be thrown out. Beets will be carefully plowed out by first party, but any beets not loosened by the plow shall be dug out by second party. (4) When beets are harvested, second party shall top and load into wagons

as many tons of beets each day, as first party shall be required to deliver by the Spreckels Sugar Company. (5) To protect plowed out beets from sun and frost while in the field. Second party further agrees to personally superintend the work of cultivation and harvesting of beets, and to have it done in a proper and farm-like manner, and to the satisfaction of first party.

It is further agreed, that if second party or any men of second party shall neglect or refuse to comply with above conditions, or neglect or refuse to perform any of above operations at time set or in manner prescribed by first party, that first party shall have the right and option to cancel this contract; and any money that may have become due to second party on account of work performed shall be forfeited to first party; or it shall be optional with first party to put in men to complete any work unfinished or neglected by second party or any men of second party, and charge the cost of such labor to second party.

In Consideration Whereof, first party agrees: (1) To provide transportation to and from the land aforesaid for men and baggage of second party. (2) To furnish second party with hoes, files and knives to be used in the cultivation and harvesting of beets. Said hoes, files and knives to be returned in good order as soon as work on beets is finished. (3) To provide houses or tents, wood for cooking purposes and water to men of second party while they shall be engaged in cultivation and harvesting of beets. (4) That after beets shall be all thinned and hoed to the satisfaction of first party to advance unto second party the sum of —— per acre, for each acre of beets so thinned and hoed: the amount of said advances to be deducted from first moneys that shall become due under this contract until first party is reimbursed. (5) To pay unto second party —— in gold coin or its equivalent, per ton for all beets cultivated in accordance with the terms of this agreement and delivered from land aforesaid, on the fifteenth day of the next month after the beets are delivered. Payment for beets shall be based upon actual weight of washed beets received by factory in Watsonville or Spreckels.

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DOMESTIC SUGAR PRODUCERS ORGANIZED.

The American Sugar Growers' Society is the organized center of this new industry. Its objects are as follows:

1. To secure for American farmers, laborers and capitalists the American market for American grown sugar, instead of having the American market supplied with the product of the highly protected and bounty-fostered beet sugar industry of Europe, or of the cane sugar industry of the cheap labor countries of Africa and the East.

2. To put into the pockets of the American people the $100,000,000 now sent abroad annually for imported sugar—one billion dollars every ten years. A sum which within a dozen years or so may be $200,000,000 annually!

3. To show the American people that this upbuilding of what is destined to be one of the greatest of American industries and one of the most beneficent to American agriculture, can be done without injustice to others and without unduly advancing prices to consumers, but so that the enormous sums now sent out of the country every year may be distributed among our own farmers and others engaged in cultivating the thousands of acres of sugar beets and cane, and in operating the hundreds of enormous factories required to supply the people of the United States with sugar.

4. These results to be aided by (1) appropriate tariff legislation to offset foreign export bounties and to afford reasonable protection against foreign competition; by (2) maintaining the same duties against sugar from the tropics as from other countries, in the future as in the past, irrespective of the political relations of the East Indies or the West Indies to the United States; and (3) by whatever encouragement may be offered by the respective states and by localities that desire to secure sugar factories.

5. In addition to these objects, the American Sugar Growers' Society, through its local and state organizations, will encourage farmers to become experts in beet and cane culture, will act as a medium through which capitalists and others who wish to start factories may reach localities that want factories, and will in every proper, reasonable and legitimate way do all in its power to promote the best development of our domestic sugar industry. The society will resist and try to prevent or circumvent any unjust action toward the industry that may be attempted by the sugar trust, and will do its utmost to secure for the growers of beets and cane the fullest measure of whatever help may be extended to the industry by state or nation.

Officers of the American Sugar Growers' Society—President, R. M. Allen of Ames, Neb., president Nebraska Sugar Beet Growers' Association; first vice-president, Charles A. Farwell of New Orleans, La., president United States Cane Growers' Association. Treasurer, Herbert Myrick of 52 Lafayette Place, New York, president Orange Judd Company, and editor American Agriculturist of New York, and Orange Judd Farmer of Chicago, Ill.; secretary, B. W. Snow, Marquette Building, Chicago, Ill., statistician Orange Judd Farmer.

PARTIAL LIST OF PLACES THAT WANT SUGAR FACTORIES.

Many other communities, whose addresses there has not been time to compile, are also making efforts to obtain sugar mills. The persons named below are those identified with the movement at the localities named.

Postoffice	*County*	*Name*
ARIZONA.		
Phoenix	Maricopa	W. S. Devol
Winslow	Apache	S. M. Folsom Greenfield, Mass.
ARKANSAS.		
Olyphant	Jackson	C. E. Frizzell
Fort Smith	Sebastian	H. H. Hoover
Fort Smith	Sebastian	S. A. Williams
Rogers	Benton	H. B. Woodcock
CALIFORNIA.		
Chino	San Bernardino	Valley Sugar Co
Vacaville	Solano	E. G. Davis
Napa	Napa	C. L. James
Wheatland	Yuba	E. E. Oakley
Chico	Butte	J. McStilson
Salinas	Monterey	James Bardin
Fulton	Sonoma	A. Bannister
Gridley	Butte	L. K. Vaugham
Los Angeles	San Bernardino	Columbia Colonization Co
COLORADO.		
Mosca	Costilla	J. R. Patterson
Rhone	Mesa	Henry R. Rhone
Pueblo	Pueblo	Suburban Land & Investment Co
Denver	Arapahoe	Lute Wilcox
La Salle	Weld	R. W. Devinny
Grand Junction	Mesa	C. E. Mitchell
FLORIDA.		
De Funiak Springs	Walton	S. E. Wolf
Ocoee	Orange	T. L. Joyce
Auburndale	Polk	Irving Page
St Cloud	Osceola	Col Allen Thomas
Jacksonville	Duval	S. Powers
Lake City	Columbia	H. E. Stockbridge
IDAHO.		
Payette	Canyon	Eugene Autz
Leduc	Blaine	P. Leduc
ILLINOIS.		
Alma	Marion	W. S. Ross
Monterey	Fulton	D. W. Kelsey
Litchfield	Montgomery	R. S. Nelson
Niota	Hancock	Jacob Zeh
Milford	Iroquois	I. D. Gillum
Mt Carmel	Wabash	W. H. Wildey
Chemung	McHenry	Joseph Kuhby
Forest City	Mason	A. D. Brown
Monmouth	Warren	C. E. Corneli
Ottawa	Lasalle	C. E. Fisher
Kankakee	Kankakee	Leon Hay
Momence	Kankakee	Will Lewis
Chemung	McHenry	Joseph Kuhler
Nekoma	Henry	Robert Lapan
Mulkeytown	Franklin	Scott Clark
Havana	Mason	E. A. Wallace
Buffalo Grove	Lake	J Weidner & Sons
Polo	Ogle	J. N. Sanborn
Ottawa	Lasalle	I. B. Lovejoy
McHenry	McHenry	J. Van Slyke
Pittsfield	Pike	F. L. Shriver

Postoffice	*County*	*Name*
ILLINOIS (CONTINUED).		
Jerseyville	Jersey	A. W. Cross
Metropolis City	Massac	A. N. Starkes
Morrison	Whiteside	E. A. Smith
Galesburg	Knox	Robert Chappel
Effingham	Effingham	William Dyke
Pekin	Tazewell	Ill. Sugar Refining Co
INDIANA.		
Fort Wayne	Allen	Alexander Johnson
Bluffton	Wells	L. A. Williams
Wabash	Wabash	S. Haas
Columbia City	Fayette	J. M. Harrison
Monroeville	Allen	W. Dickerson
Aurora	Dearborn	J. Small
Monroeville	Allen	N. R. Spaulding
Bluffton	Wells	W. K. Shoemaker
Logansport	Cass	J. H. Barnhalt
Elwood	Madison	W. E. Broyles
Laud	Whitley	Lewis Deems
Dana	Vermilion	W. B. Hood
Zionsville	Boone	J. W. Lane
Owensville	Gibson	Levi Skelton
Francesville	Pulaski	W. Benson
New Harmony	Posey	F. Mumford
Morocco	Newton	J. M. Rogers
Fort Wayne	Allen	H. C. Rockhill
Liberty	Montgomery	Ben Snyder
Madison	Jefferson	C. E. Cosby
Evansville	Vanderburg	C. Cordes
Delphi	Carroll	V. L. Ricketts
Newcastle	Henry	A. D. Ogborn
Lowell	Lake	J. Dinwiddie
Columbus	Bartholomew	W. T. Stott
Seymour	Jackson	J. H. Hodapp
Vincennes	Knox	Edward Watson
North Judson	Starke	Jacob Keller
IOWA.		
Gr'd Junct'n	Greene	Mrs C. D. Park
Wapello	Louisa	W. S. Kremer
Diagonal	Ringgold	O. B. Overholser
Fontanelle	Adair	F. M. Daugherty
Schaller	Sac	E. W. Bennett
Newell	Buena Vista	J. Jenson
Spencer	Clay	J. C. Winset
Greene	Butler	E. H. Beal
Ames	Story	James Wilson
Dubuque	Dubuque	M. H. Moore
Davenport	Scott	Bus's Men's Ass'n
Clinton	Clinton	S. M. Highlands
Charles City	Floyd	J. W. Brown
Fort Dodge	Webster	J. B. Butler
Muscatine	Muscatine	W. G. Block
Waterloo	Blackhawk	C. P. Bratnober
Mason City	Cerro Gordo	G. C. Winter
Britt	Hancock	Dr A. J. Cole
Keokuk	Lee	Arthur H. Moody
Casey	Guthrie	G. W. Osgood
Waukon	Allamakee	H. E. Teeple
Primghar	O'Brien	J. H. Wolf
Le Mars	Plymouth	G. E. Richardson
Des Moines	Polk	A. H. Meyer
Sidney	Fremont	J. R. McKee

Postoffice	County	Name
KANSAS.		
Humboldt	Allen	J. J. Amos
N. Wichita	Sedgwick	S. F. Toler
Indep'nd'nce	Montgomery	Mrs A. B. Clark
Topeka	Shawnee	Investment Trust Co
Irving	Marshall	Grant Ewing
Ellinwood	Barton	C. Kattenholm
Oketo	Marshall	C. M. Knight
N. Topeka	Shawnee	W. E. Clark
Topeka	Shawnee	F. D. Coburn
Paola	Miami	E. T. Ahrens
Iola	Allen	C. F. Scott
Rosedale	Wyandotte	Henry Senecal
Leoti	Wichita	J. G. Donnell
Salina	Saline	L. A. Will
KENTUCKY.		
Lexington	Fayette	B. M. Cole
Hopkinsville	Christian	T. E. Elgin
Valley St'n	Jefferson	W. W. Moremen
Morganfield	Union	C. F. Hart
Carrollton	Carroll	O. M. Wood
Warsaw	Gallatin	D. B. Wallace
Hartford	Ohio	S. A. Anderson
Cloverport	Breckinridge	John D. Baggage
Jackson	Breathitt	T. M. Morrow
LOUISIANA.		
New Iberia	Iberia	J. T. White
Schriever	Terrebonne	J. T. Moore, Jr
Crowley	Acadia	John P. Hoyt
MASSACHUSETTS.		
Springfield	Hampden	Nathan D. Bill
MICHIGAN.		
Niles	Berrien	J. T. Barker
Oak	Wayne	J. C. Jackson
New Era	Oceana	J. E. Farnham
Fenton	Genesee	F. A. Bosworth
White Cloud	Newaygo	W. E. Fulkerson
Petoskey	Emmet	A. O. Jenne
Port Huron	St Clair	Cyrus Hovey
Capac	St Clair	S. C. Draper
Mt Pleasant	Isabella	T. P. Collin
Charlotte	Eaton	G. M. Fenn
Cranston	Oceana	E. Morrissey
Port Huron	St Clair	L. B. Rice
Millington	Tuscola	W. J. Haines
Yale	St Clair	J. H. Merrill
Chevingston	Sanilac	S. A. Hillman
Dearborn	Wayne	W. H. Manwell
Roseburg	Sanilac	J. Aver
Kalamazoo	Kalamazoo	J. E. Welborn
White Cloud	Newaygo	M. D. Haywood
Benton Harbor	Berrien	F. R. Gilson
Port Huron	St Clair	L. A. Sherman
St Ignace	Mackinac	C. G. Cavanagh
Alpena	Alpena	W. T. Sleator
Mt Pleasant	Isabella	W. E. Preston
Hart	Oceana	J. D. S. Hanson
Lapeer	Lapeer	S. D. Brown
Clare	Clare	L. E. Davy
Detroit	Wayne	Milton Carmichael
Kalkaska	Kalkaska	A. E. Palmer
Grayling	Crawford	R. Hanson
Traverse City	Grand Traverse	Thomas T. Bates
Marshall	Calhoun	W. J. Gregg
Ovid	Clinton	W. H. Faxon
Ashton	Oceola	Wilson Showalter
Pierson	Montcalm	M. H. Holcomb
Northville	Wayne	Morris Lancaster
Mancelona	Antrim	Geo. Irwin
Durand	Shiawassee	H. D. Soule
Shabbona	Sanilac	David Leslie
Galesburg	Kalamazoo	James H. Wolf
Clinton	Lenawee	A. T. Kishpaugh
Nadeau	Menominee	G. T. Werline
Willis	Washtenaw	C. E. Lord
Pigeon	Huron	A. Kleinschmidt
Newaygo	Newaygo	Will Courtright
Gaylord	Otsego	Charles Wyllys
Sault de Sainte Marie	Chippewa	William Chandler
Cheboygan	Cheboygan	E. O. Penney
Saginaw	Saginaw	R. F. Johnson
Grand Haven	Ottawa	Keorman & Zaagman
East Tawas	Iosco	The Mayor
W. Bay City	Bay	S. O. Fisher
MINNESOTA.		
Rush City	Chisago	J. S. McDonald
Faribault	Rice	O. F. Brand
Winona	Winona	Max A. Goltz
Madison	Lac Qui Parle	P. K. Haslernd
Stockton	Winona	Benj. Sherry
Madison	Lac Qui Parle	J. H. Guenther
Dawson	Lac Qui Parle	A. J. Peterson
Hinckley	Pine	J. J. Folsom
Chaska	Carver	F. E. Du Toit
St James	Watonwan	F. B. Lynch
Winona	Winona	J. Slingerman
Northfield	Rice	John Lawson
Cloquet	Carlton	Fred Vilbert
Winona	Winona	W. E. Walker
Belle Plaine	Scott	Peter Becker
Aitken	Aitken	B. M. Hungerford
Boyd	Lac Qui Parle	E. P. Johnson
Worthington	Nobles	C. M. Crandall
Mankato	Blue Earth	Chas. A. Chapman
MISSISSIPPI.		
Natchez	Adams	C. B. Brownell
MISSOURI.		
Marceline	Linn	S. H. Linton
Maltabend	Saline	H. F. Knapp
Bucklin	Linn	R. K. Kinney
West Alton	St Charles	P. A. Edalin
Ballwin	St Louis	E. L. Kern
Kirksville	Adair	W. T. Baird
Canton	Lewis	C. W. Barrett
Clinton	Henry	Commercial Club
Montgomery City	Montgomery	Dr C. B. Faulconer
Boonville	Cooper	John M. Humber
MONTANA.		
Great Falls	Cascade	G. A. Gray
Missoula	Missoula	Verdie Spurgin
Chinook	Choteau	W. M. Wooldridge
NEBRASKA.		
Indianola	Redwillow	J. S. Phelps
Lincoln	Lancaster	M. R. Moret
York	York	L. M. Street
Wakefield	Dixon	S. P. Johnson
Ord	Valley	T. S. Harris
Wayne	Wayne	F. M. Northrop
Dorchester	Saline	Frank Roop
Callaway	Custer	J. Reinhard
Sunflower	Scotts Bluff	C. H. Simmons
Ainsworth	Brown	C. W. Potter
Omaha	Douglas	W. N. Nason
Auburn	Nemaha	W. H. Stowell
Wayne	Wayne	F. A. Dearborn
Weeping Water	Cass	A. L. Timblin
Gibbon	Buffalo	C. H. Winchester
Redcloud	Webster	W. L. McMillan
Schuyler	Colfax	J. P. McCullough
Brokenbow	Custer	E. B. Purcell
Neligh	Antelope	E. T. & C. J. Best
Dorp	Logan	Charles W. Parker
NEW HAMPSHIRE.		
Wolfboro	Carroll	S. Brummitt

Postoffice	County	Name
NEW JERSEY.		
Annandale	Hunterdon	M. F. Gand
Hainesburg	Warren	E. O. Ward
Stanton	Hunterdon	Frank Bird
Passaic	Passaic	O. Hepburn
Glen Gardner	Hunterdon	S. F. Bell
High Bridge	Hunterdon	J. H. Exton
Blackwood	Camden	Charles F. Currie
NEW MEXICO.		
Sante Fe	Santa Fe	S. M. Folsom
Las Cruces	Donna Ana	F. C. Barker
Maxwell City	Colfax	E. S. Warren
Raton	Colfax	Maxwell Land Grant Co
NEW YORK.		
McLean	Tompkins	B. L. Robertson
Lansingville	Tompkins	W. J. Emmons
Schodaek Landing	Rensselaer	J. W. Knicker-bocker
Bralnard	Rensselaer	J. D. Tompkins
Bennettsvill	Chenango	E. C. Ward
Potsdam	St Lawrence	Harry H. Fay
Earlville	Madison	G. H. Clark
Bondville	Montgomery	L. W. Griswold
Akin	Montgomery	J. K. Mosher
Union	Broome	E. K. Mersereau
Falconer	Chautauqua	M. A. Sealy
Westbury	Cayuga	J. M. Shotwell
Alabama	Genesee	H. J. Williams
Newark	Wayne	P. W. Stuart & Co
W Henrietta	Monroe	W. S. Dunn
Middlebury	Schoharie	W. E. Bassler
Stockton	Chautauqua	P. M. Elmer
Gloversfield	Fulton	W. H. Warren
Port Byron	Cayuga	S. D. Gutchess
New York	New York	M. Griffith & Co
Fonda	Montgomery	J. H. Beareroft
Cobleskill	Schoharie	A. B. Borst
E Schuyler	Herkimer	Jno. Collins, Jr
Nichols	Tioga	G. A. Ingersoll
Burnt Hills	Saratoga	S. Russell Jones
Evans Mills	Jefferson	Jerome Hibbard
Lyons Falls	Lewis	C. C. Merriam
Fairport	Monroe	J. McMillan
Sterling	Cayuga	J. E. McFadden
North Chili	Monroe	G. A. Osmun
Oswego	Oswego	Byron Worden
Red Hook	Dutchess	J. A. Fraleigh
Phelps	Ontario	W. H. Hicks
Ridgeland	Monroe	Lewis Curtis
Ithaca	Tompkins	I. P. Roberts
Batavia	Genesee	David B. Lent
Morrisville	Madison	John Reidy
Watertown	Jefferson	The Times
Potsdam	St Lawrence	E. J. Eastman
Binghamton	Broome	E. F. Jones
Falconer	Chautauqua	A. D. Warren
Trumansburg	Tompkins	E. A. Hawks
Texas Valley	Cortland	Elihu Sweet
Clinton	Oneida	J. H. Dodge
Collins	Erie	F. J. Quigley
Erin	Chemung	Leon E. Goodrich
Amityville	Suffolk	T. W. C. Du Puy
Wells Bridge	Otsego	A. D. Bunch
Poolville	Madison	G. M. Bronson
Yates	Orleans	E. H. Parsons
Binghamton	Broome	I. E. Rogers
Afton	Chenango	Geo. B. Burghdorf
Lewis	Essex	R. T. Moran
Brookfield	Madison	M. L. Fisk
East Elma	Erie	Mrs Jas. Hopper
Unionsville	Orange	Clevel'd Cider Co
Johnston	Orange	Isaiah Yarmey
NORTH CAROLINA.		
Sidney	Beaufort	W. N. Archbell
NORTH DAKOTA.		
Bismarck	Burleigh	J. A. Field
Hawkinson	Richland	R. A. Tyson
Larimore	Grand Forks	T. C. Bruyere
Devils Lake	Ramsey	Wm. H. Brown
Mandan	Morton	R. M. Tuttle
Lisbon	Ransom	R. T. Adams
OHIO.		
Canton	Stark	H. A. Cavnah
Caledonia	Marion	L. J. Russell
Prospect	Marion	E. G. Stockman
Bloomingbury	Fayette	L. Eggleston
Covington	Miami	Z. F. Albaugh
Napoleon	Henry	J. C. Davis
Gr'd Rapids	Wood	Azor Thurston
Defiance	Defiance	J. O. Wissler
Dunkirk	Hardin	D. F. Fryer
Chillicothe	Rose	James A. Wood
Mad River	Clark	C. B. Crain
New Philadelphia	Tuscarawas	S. F. Sweitzer Dr. H. Troendly
Cleveland	Cuyahoga	J. F. Kilby
Hillsboro	Highland	W. G. Richards
Quincy	Logan	J. M. Sullivan
Smithville	Wayne	J. W. Buchanan
Delta	Fulton	M. S. Sargent
Wauseon	Fulton	F. H. Kelsey
Herring	Allen	E. L. Lurbin
Urbana	Champaign	J. Harlzter
Coshocton	Coshocton	W. Burns
Danbury	Ottawa	H. Bredbeck
N Bavaria	Henry	J. A. L. Derr
Antwerp	Paulding	W. F. Fleck
Clyde	Sandusky	H. G. Gibbons
Leipsic	Putnam	J. A. Hummon
Pleasant Hill	Miami	Nathan Hill
Brunswick	Medina	Anton Leister
Utica	Licking	W. W. Reynolds
Granville	Licking	W. H. Williams
Akron	Summit	F. A. Wilcox
Canal Dover	Tuscarawas	J. A. Wagner
Creston	Wayne	J. South
Ravenna	Portage	J. H. Evans
Sandusky	Erie	J. Jareckl, Jr
Crayon	Champaign	B. F. Long
Delta	Fulton	M. S. Sargent
Upper Sandusky	Wyandot	S. A. Cunea
Paulding	Paulding	J. R. Ross
Medina	Medina	F. H. Leach
Bucyrus	Crawford	Ev'n'g Telegraph
Deshler	Henry	J. C. H. Elder
Flushing	Belmont	James Parks
Jerome	Union	H. Riebel
Middle Branch	Stark	F. E. Immel
Madisonburg	Wayne	B. A. Hoffman
Columbiana	Columbiana	Albert Sample
Hector	Putnam	W. D. Millspaugh
OKLAHOMA.		
Pawnee	Pawnee	H. E. Hollingsworth
OREGON.		
Forest Grove	Washington	A. Buxton
Corvallis	Benton	L. Walker
Newberg	Yamhill	F. A. Morris
Portland	Multnomah	G. A. Cooper
Lebanon	Linn	J. S. Hughes
Myrtle Creek	Douglas	P. T. McGee
Monitor	Marion	J. R. White
Oakland	Douglas	O. G. Estes
Knappa	Clatsop	C. Borglund
Myrtle Creek	Douglas	Henry Trower
Tigardville	Washington	E. G. Godman
PENNSYLVANIA.		
New Castle	Lawrence	Kirk & Smith
Lancaster	Lancaster	J. Bosler, Jr
Roland	Center	H. R. Curtin

Postoffice	County	Name
PENNSYLVANIA (CONTINUED).		
Falls Creek	Clearfield	Amos Goss
Salem	Snyder	C. Miller
Wetona	Bradford	D. Tracy
Prichard	Luzerne	W. W. Prichard
Gregory	Luzerne	R. A. Van Horn
Penns Manor	Bucks	A. R. Ellis
Meadville	Crawford	A. W. Williams
Coplay	Lehigh	E. H. Tate
Littletown	Adams	D. B. Alleman
Butler	Butler	I. McJunkin
New Brighton	Beaver	R. McLaughlin
Lanesboro	Susquehanna	J. A. Taylor
Carlisle	Cumberland	Frank Bosler
Schuylkill Haven	Schuylkill	E. L. Thomas
SOUTH DAKOTA.		
Mitchell	Davison	O. L. Branson
Yankton	Yankton	J. W. Hanson
TENNESSEE.		
Chattanooga	Hamilton	S. W. Divine
Greenfield	Weakley	T. C. Phillips
Nashville	Davidson	Col J. B. Killebrew
Gainesville	Cooke	F. A. Galigher
Sugar Land	Fort Bend	Col Cunningham
Crockett	Houston	W. C. Lipscomb
Howe	Grayson	Mrs H. Pomeroy
UTAH.		
Logan	Foster	Luther Foster
S'lt Lake City	Salt Lake	E. G. Rognon
Riverton	Salt Lake	T. P. Page
Leamington	Millard	B. P. Textorius
Hooper	Weber	R. C. Christensen
Spanish Fork	Utah	R. P. Snell
Springville	Utah	J. M. Westwood
VIRGINIA.		
Riverton	Warren	R. McCoy
Buena Vista	Rockbridge	A. T. Barclay
City Point	Prince George	R. Eppes
Staunton	Augusta	O. K. Lapham
Emporia	Greenville	H. W. Weiss
Richmond	Henrico	R. A. Dunlop
Irvington	Lancaster	W. McDonald Lee
WASHINGTON.		
Spokane	Spokane	F. E. Elmendorf
Whitman	Whitman	F. A. English
Pasco	Franklin	A. A. Batcheller
Touchet	Wallawalla	A. Farnsworth
Waupaca	Waupaca	G. W. Ogden
Juno	Chehalis	J. D. Schaefer
WEST VIRGINIA.		
Alderson	Monroe	H. T. Houston
Wolf Creek	Monroe	G. T. Leatherman
Old Fields	Hardy	A. L. Miller
Clarksburg	Harrison	T. Patton
Berryville	Kenosha	W. Braid
Huntington	Cabell	A. J. Beardsley
WISCONSIN.		
Waupaca	Waupaca	Frank Gruner
Scandinavia	Waupaca	C. H. Anderson
Cedarburg	Ozaukee	T. Halpin
Evansville	Rock	H. L. Austin
Augusta	Eau Claire	E. J. Frear
Brillion	Calumet	E. G. Fuller
New Holstein	Calumet	A. A. Paulsen
Black Wolf	Winnebago	C. F. Hart
Markesau	Green Lake	W. T. Robinson
Salem	Kenosha	E. N. Ripley
Barnum	Crawford	J. M. Brownlee
Schofield	Marathon	T. W. Clark
Burnett S't'n	Dodge	H. Lawrence
Trevor	Kenosha	J. M. Orbis
Stoughton	Dane	O. J. Olson
Bear Creek	Outagamie	J. J. Weid
Winchester	Winnebago	O. H. Hanson
Merrillan	Jackson	W. A. Marr
Madison	Dane	W. A. Henry
Nellsville	Clark	L. B. Ring
Arkansaw	Pepin	Fred Pittman
Durand	Pepin	Ingram & Goodrich
Beaverdam	Dodge	H. R. Hawley
Merrillan	Jackson	R. H. Gile
Marinette	Marinette	W. C. Campbell
Barron	Barron	C. C. Coe
Kewaunee	Kewaunee	A. C. Voshart
Sumner	Jefferson	Walter Marsden
Manawa	Waupaca	Jas. Flanagan
Port Washington	Ozaukee	Geo. H. Crowns
Hillsboro	Vernon	G. A. Cressy
Wausau	Marathon	T. W. Clark
WYOMING.		
Cheyenne	Laramie	Elwood Mead